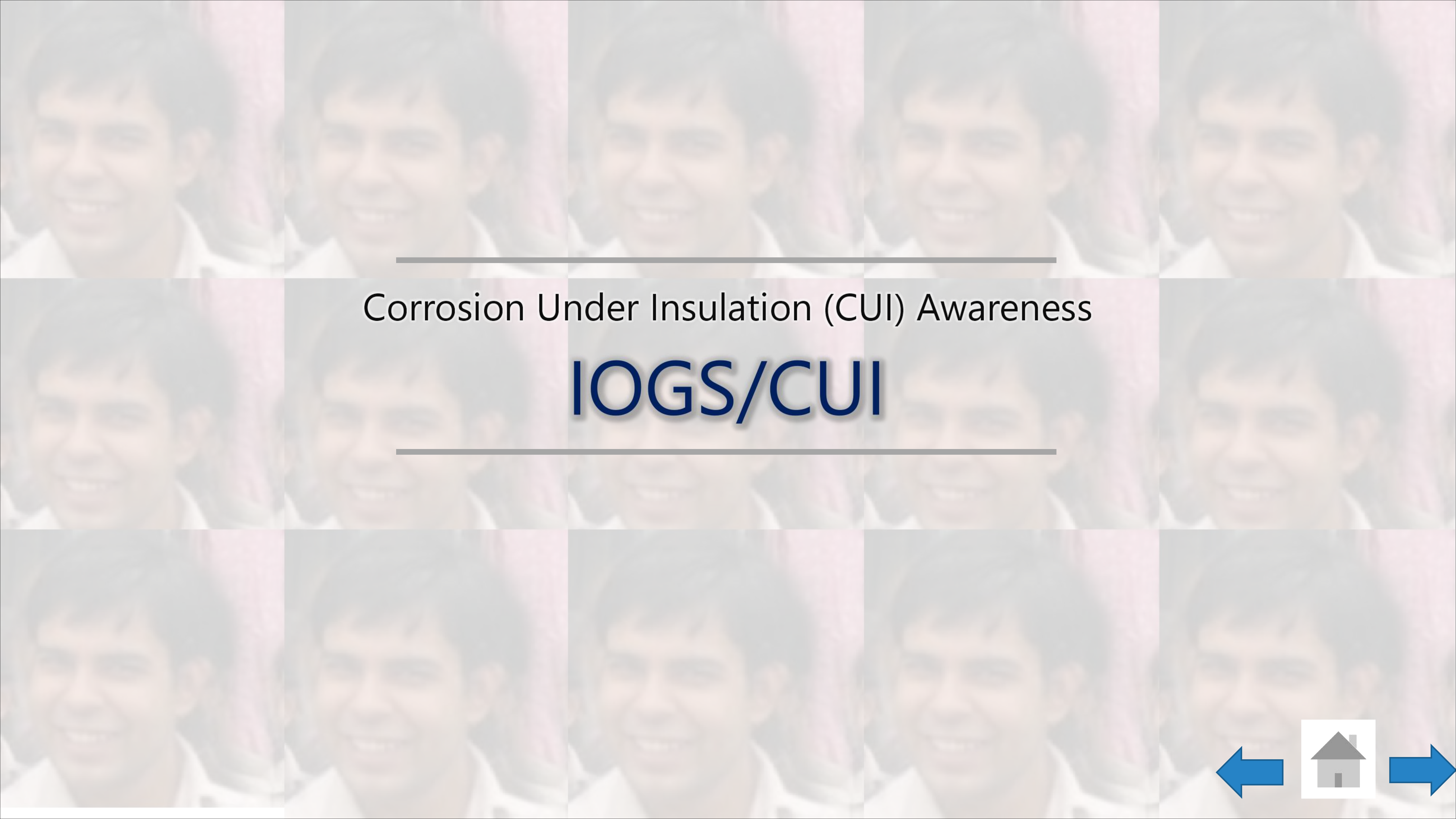


Corrosion Under Insulation (CUI) Awareness

IOGS/CUI

Chapters

CUI Introduction

Why CUI Occurs

CORROSION UNDER INSULATION

Awareness

How to Detect CUI

How to Prevent CUI

Safety Consequences Due to CUI

Chapters

CORROSION
UNDER
INSULATION

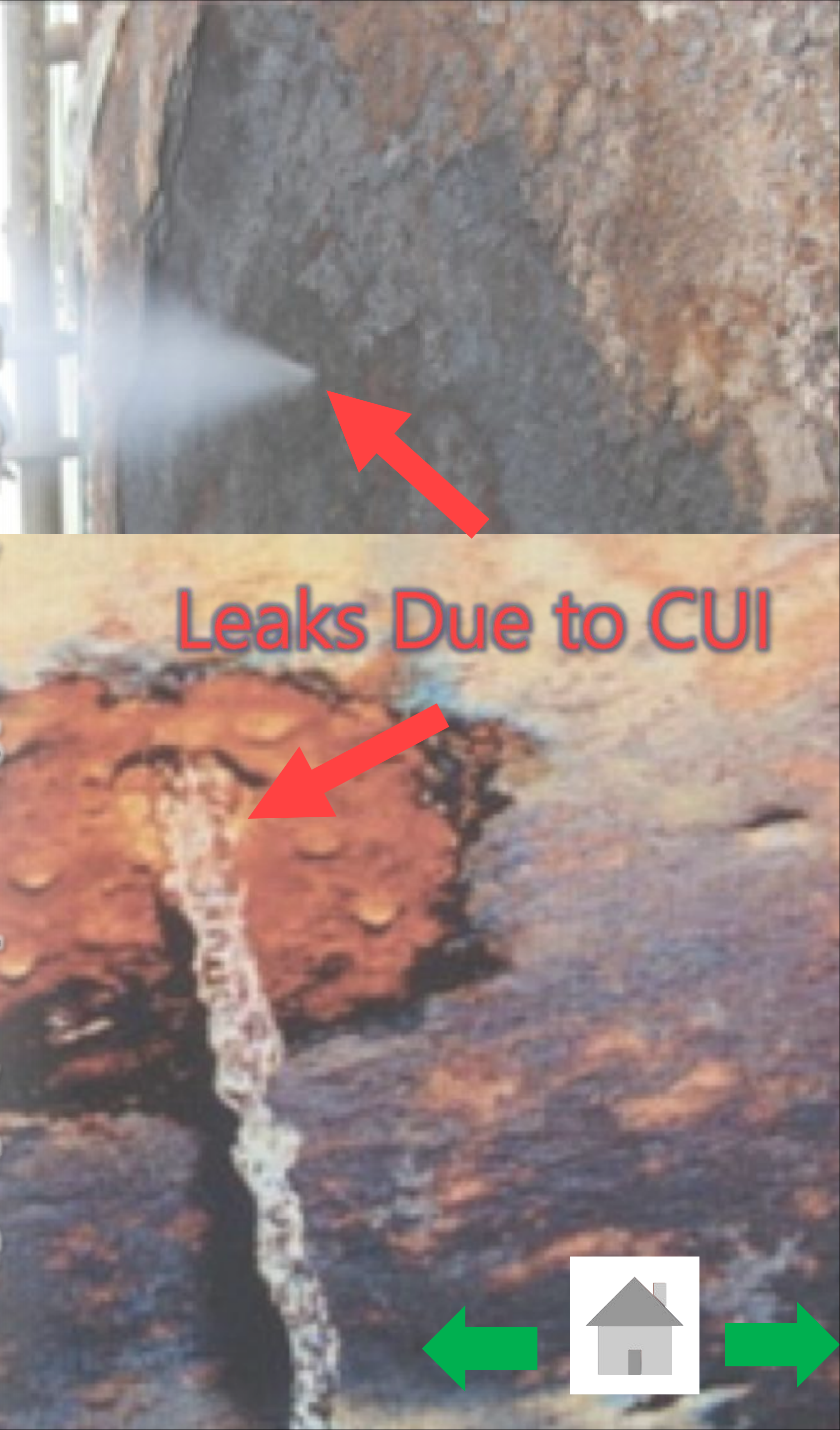
- CUI Introduction
- How CUI Occurs
- How to Detect CUI
- How to Prevent CUI
- Safety Consequence Due to CUI

CUI Introduction

- CUI is known as the hidden enemy, defined as the external corrosion of piping and equipment’s fabricated from carbon-manganese, low alloy and austenitic stainless steels that occurs underneath externally jacketed insulation owing to the penetration of water.
- CUI has been occurring for as long as hot or cold piping and equipment's have been insulated for:
    - Thermal protection
    - Energy conservation
    - Process stabilization

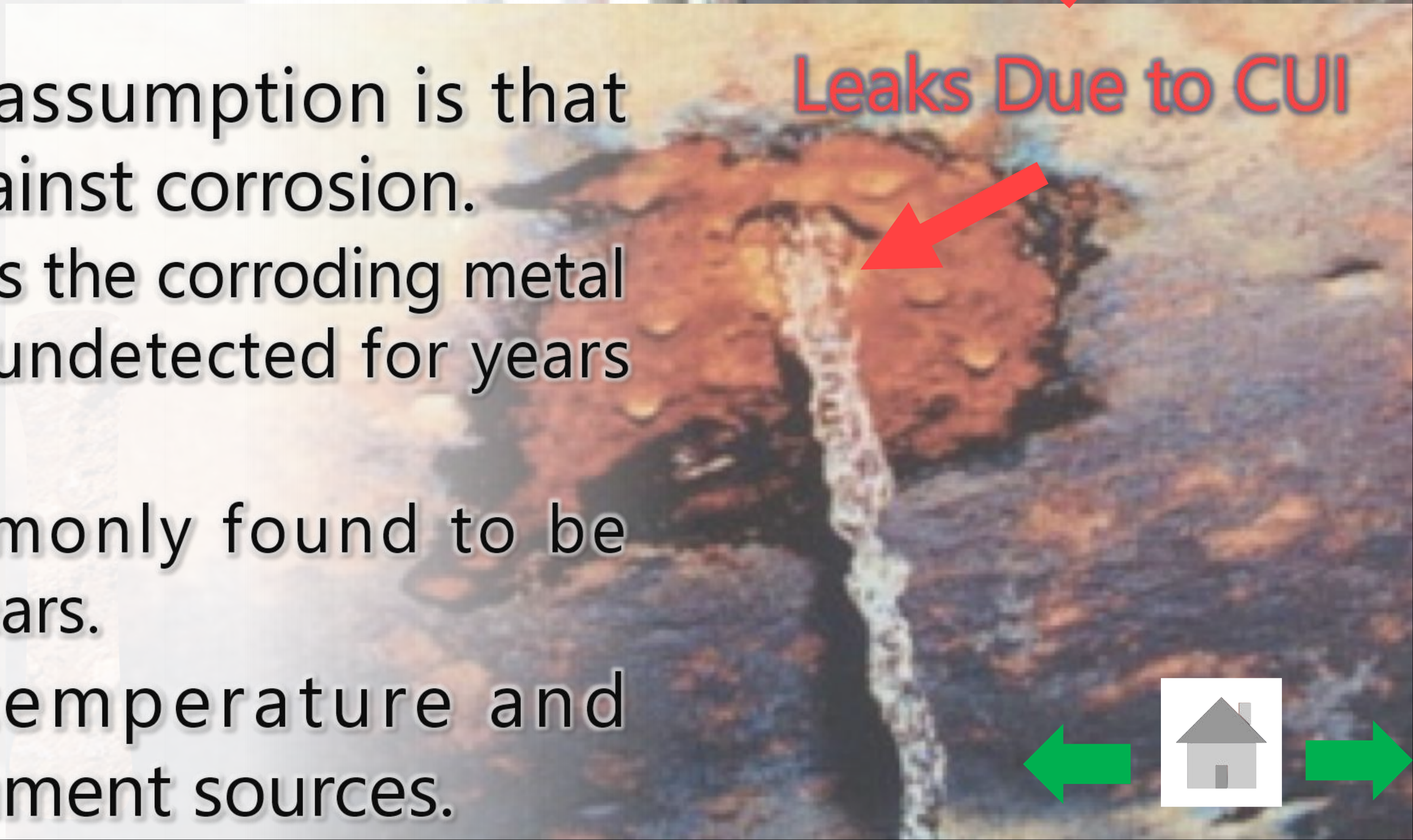
CUI Introduction

- CUI is a major common problem on a worldwide basis that is shared by all the refining, petrochemical, power, industrial, onshore and offshore industries.
- It is not a new problem, but can be a serious problem.
- CUI has been responsible for many major leaks that lead to health & safety incidents, result in lost production and are responsible for the large maintenance budgets which are required to mitigate the problem.



CUI Introduction

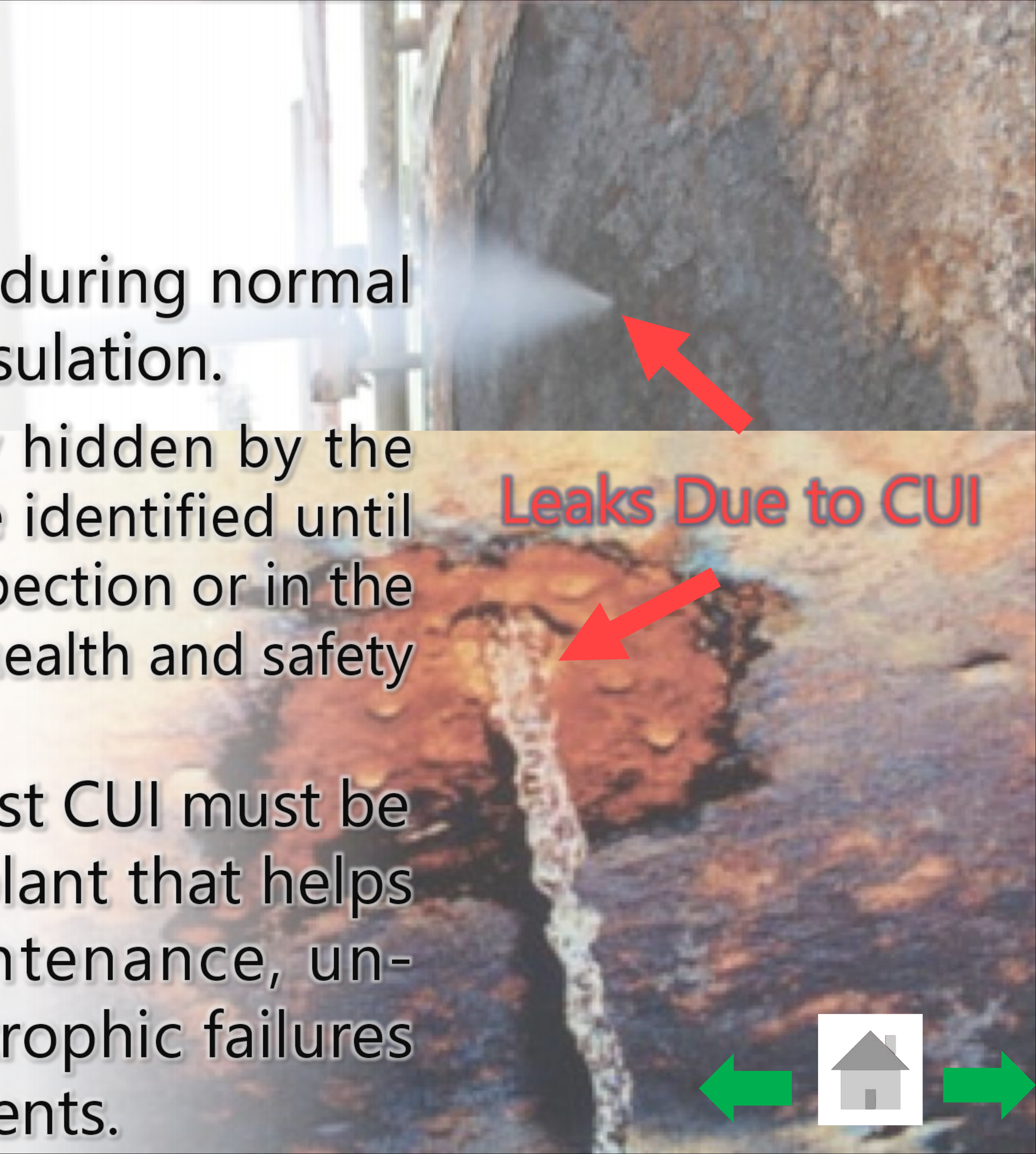
- At one chemical process plant alone, the CUI cost was reported to be in the million of dollars.
- A common but incorrect assumption is that insulation also protects against corrosion.
    - The insulation usually hides the corroding metal and the problem can go undetected for years until metal failure occurs.
    - CUI problems are commonly found to be significant after about 5 years.
- CUI rate depends on temperature and internal or external containment sources.



Leaks Due to CUI

CUI Introduction

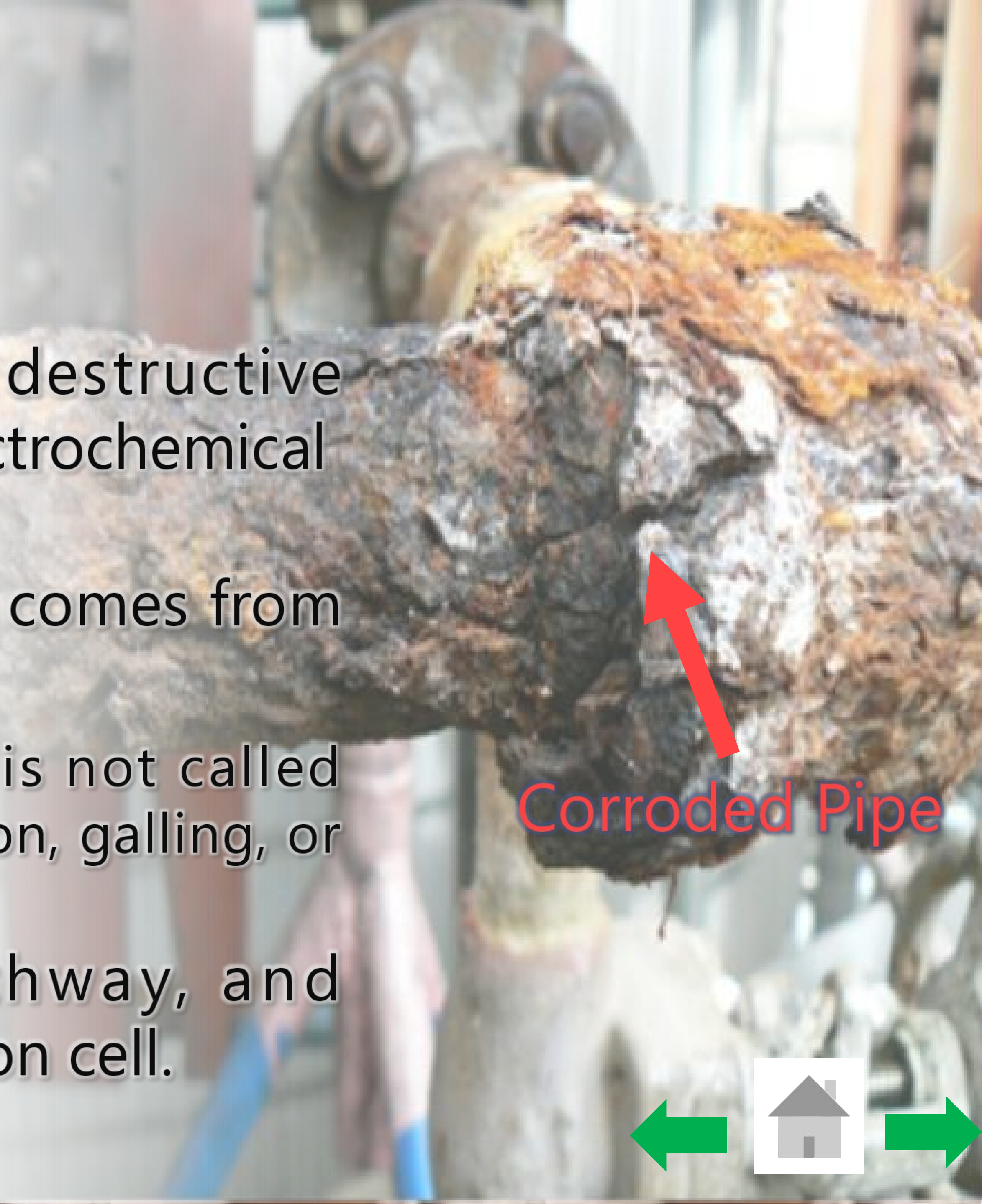
- CUI cannot be visually detected during normal service without removal of the insulation.
  - The corroded surface is mostly hidden by the insulation system and will not be identified until the insulation is removed for inspection or in the event of metal failure leading to health and safety incidents.
- The necessity of protection against CUI must be determined for each individual plant that helps preventing un-necessary maintenance, un-expected shutdowns, and catastrophic failures that lead to health & safety incidents.



Leaks Due to CUI

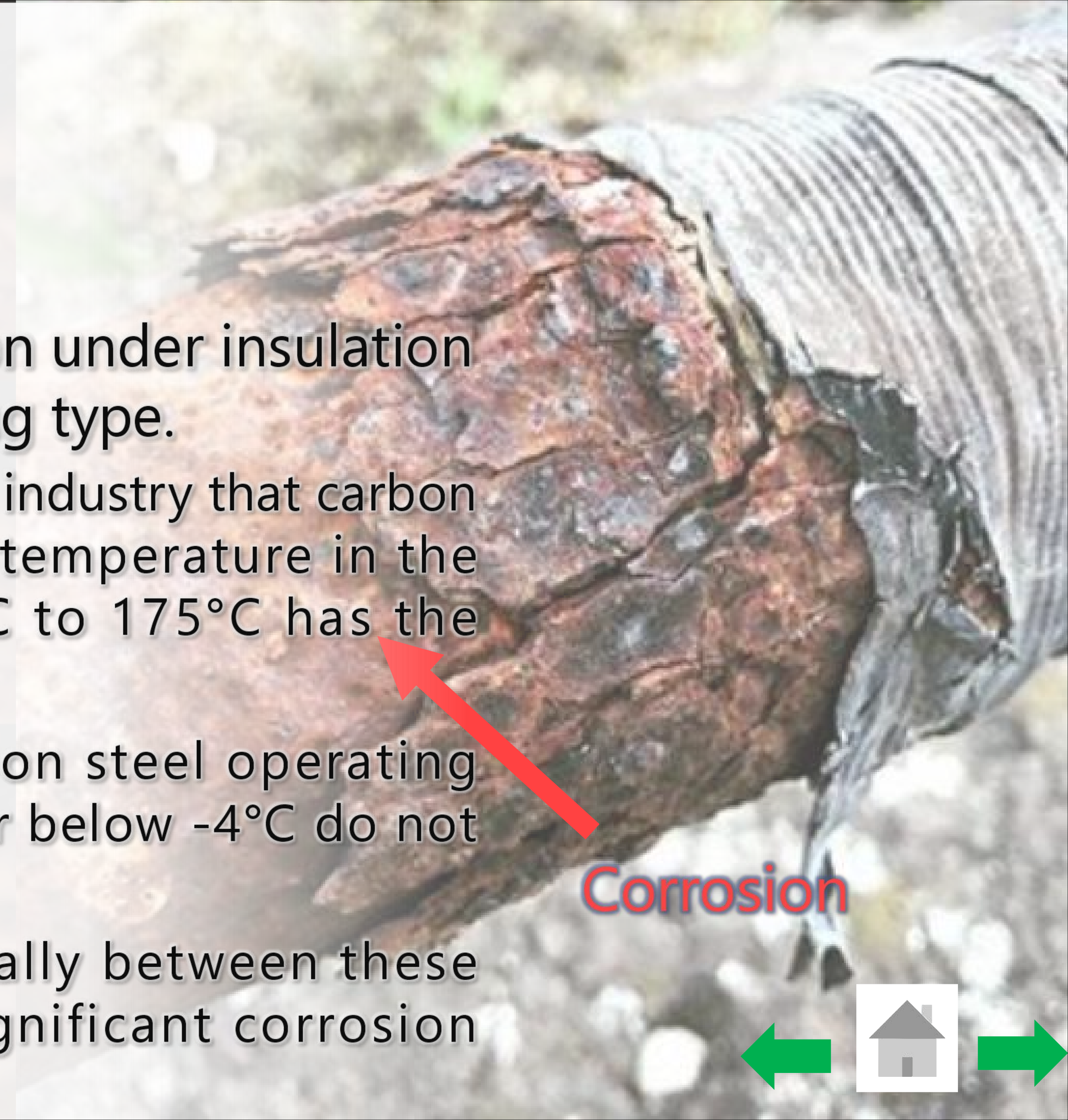
CUI Introduction

- What corrosion is?
  - Corrosion can be defined as the destructive attack of a metal by chemical or electrochemical reaction with its environment.
  - Corrosion or sometimes called rust comes from “corrous” which means eating away.
    - Deterioration by physical causes is not called corrosion, but is described as erosion, galling, or wear.
  - Anode, cathode, metallic pathway, and electrolyte are known as the corrosion cell.



CUI Introduction

- ❑ What corrosion is?
  - o On carbon steels, the corrosion under insulation is usually of a general or pitting type.
    - It has been recognized within industry that carbon steel operating with a skin temperature in the temperature range of -4°C to 175°C has the greatest likelihood of CUI.
    - Insulated surfaces for carbon steel operating continuously above 175°C or below -4°C do not present major CUI problems.
    - However, steadily or cyclically between these temperature may suffer significant corrosion problems.



CUI Introduction

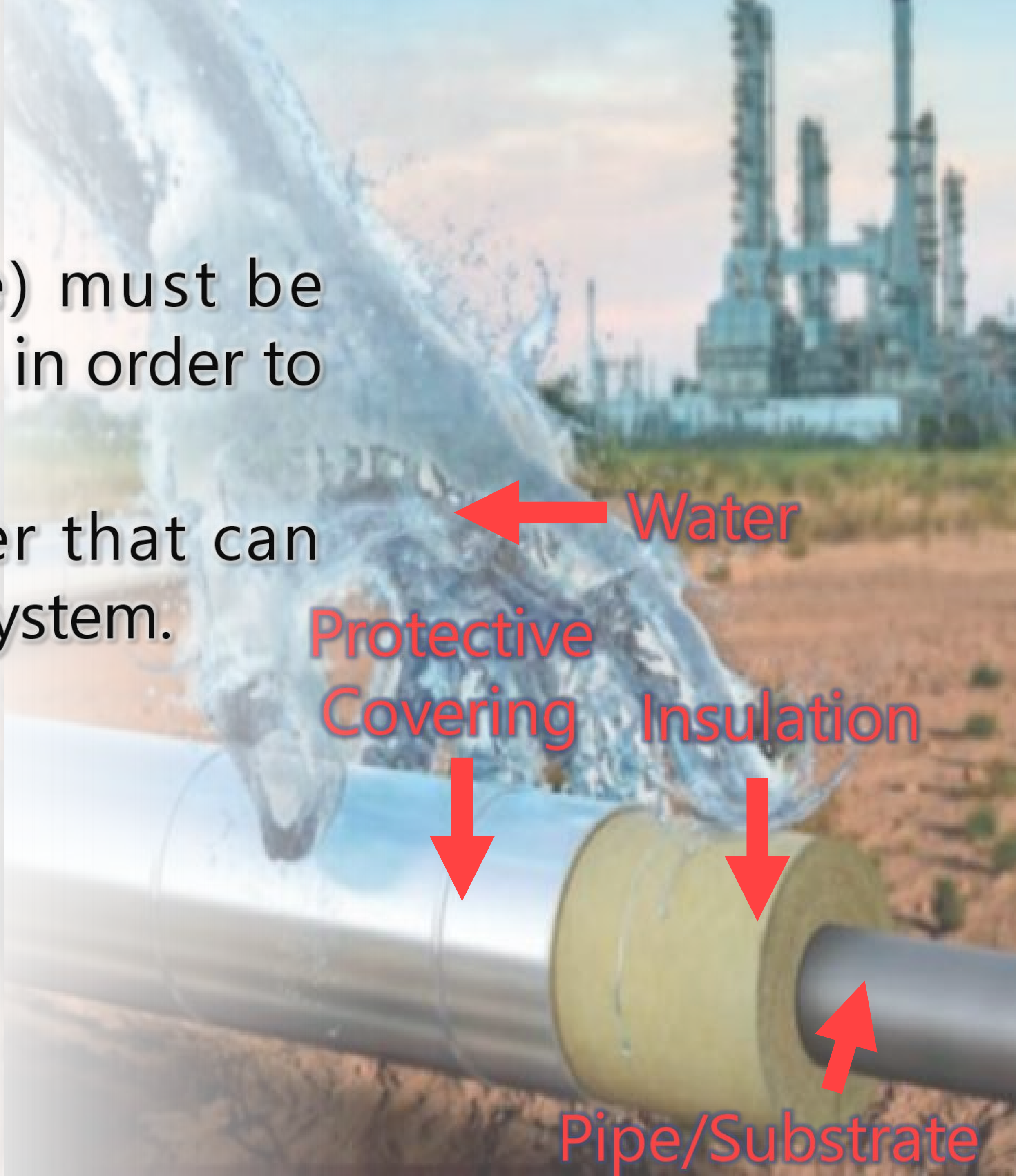
- What corrosion is?
  - On austenitic or duplex stainless steels, the corrosion is almost always chloride stress corrosion cracking (Cl-ESCC).
    - The temperature range of 50°C to 175°C has the greatest likelihood of Cl-ESCC.
    - Insulated surfaces for stainless steel operating continuously above 175°C or below 50°C do not present major Cl-ESCC problems.
    - However, steadily or cyclically between these temperature may suffer significant Cl-ESCC problems.

Why Does CUI Occur

- CUI of carbon-manganese steels and low-alloy steels usually occurs when steel is contacted by aerated water.
- A source of water, chlorides, and net tensile stress causes Cl-ESCC of austenitic stainless steel.
- CUI has been reported under all type of insulation material.
- The insulation type may only be a contributing factor.

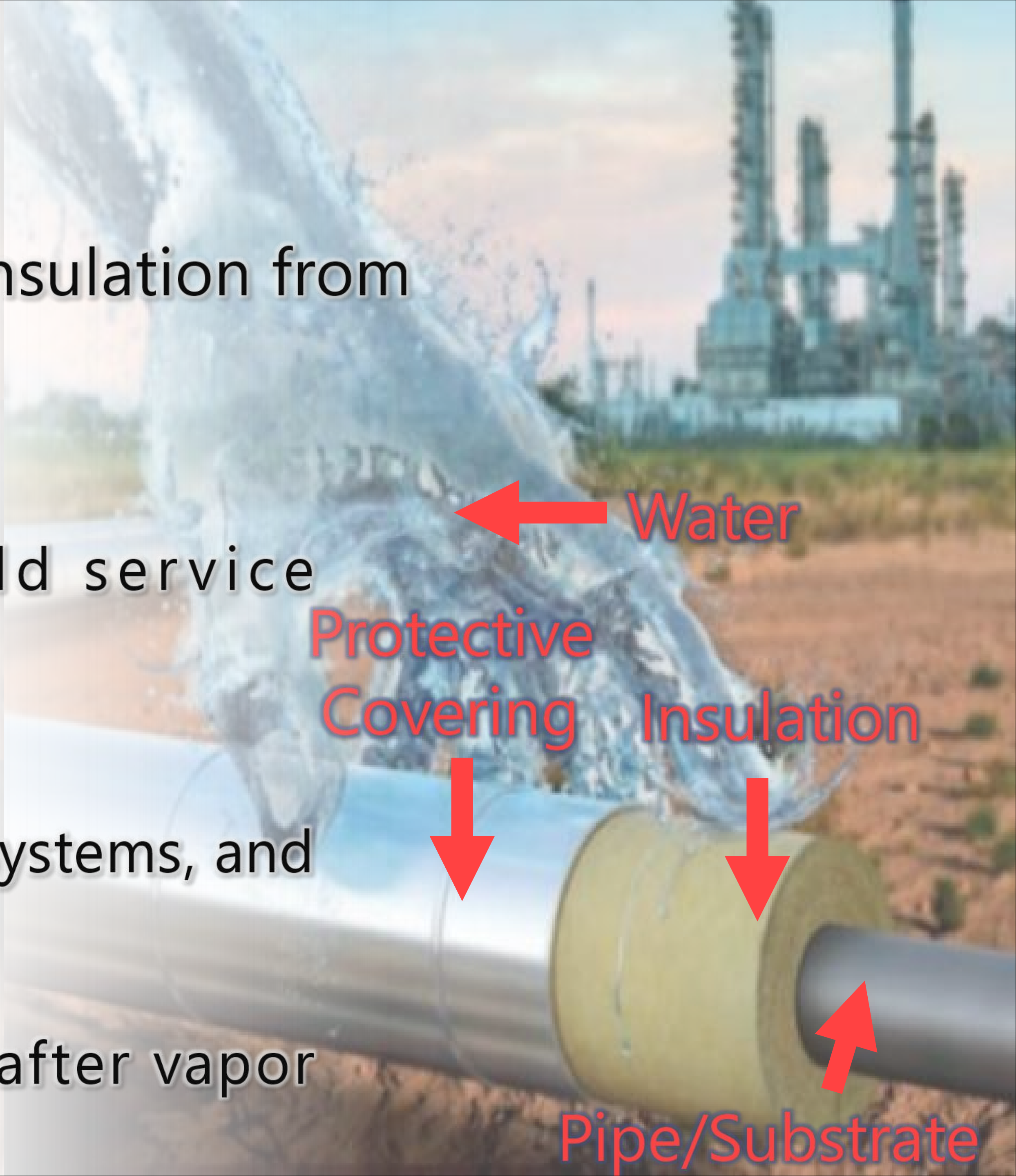
Why Does CUI Occur

- Water or moisture (electrolyte) must be present on the insulated substrate in order to allow CUI to take place.
- There are many sources of water that can enter into the installed insulation system.
- The principle source of water are:
  1. Infiltration from external sources
  2. Condensation



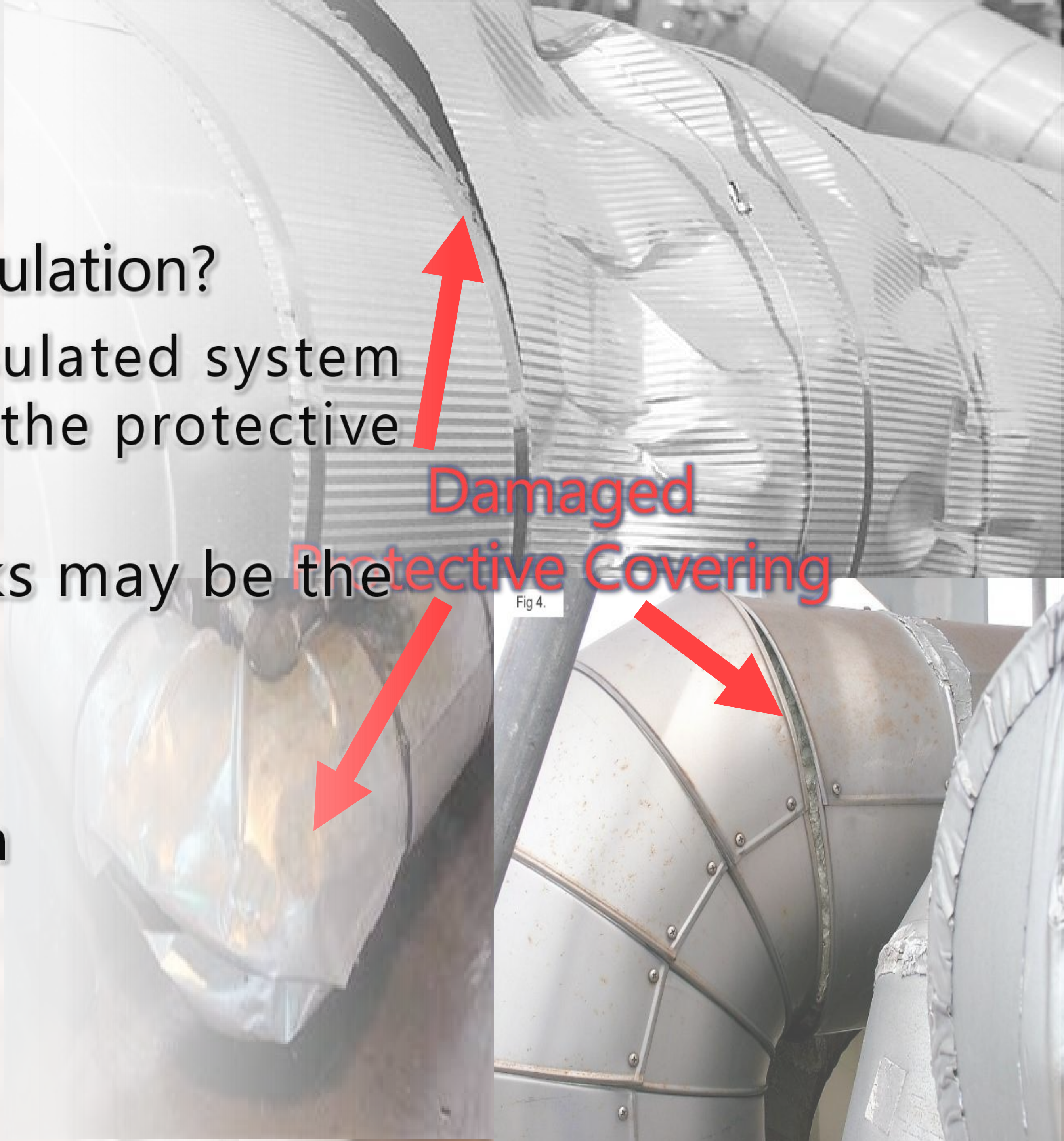
Why Does CUI Occur

- Water infiltrates/ingress into the insulation from the following external sources:
  - Rainfall
  - Drift from cooling towers
  - Condensate falling from cold service equipment's
  - Steam discharge
  - Process liquid spillage
  - Spray from fire sprinklers, deluge systems, and washdowns
  - Groundwater
  - Condensation on cold surfaces after vapor barrier damage



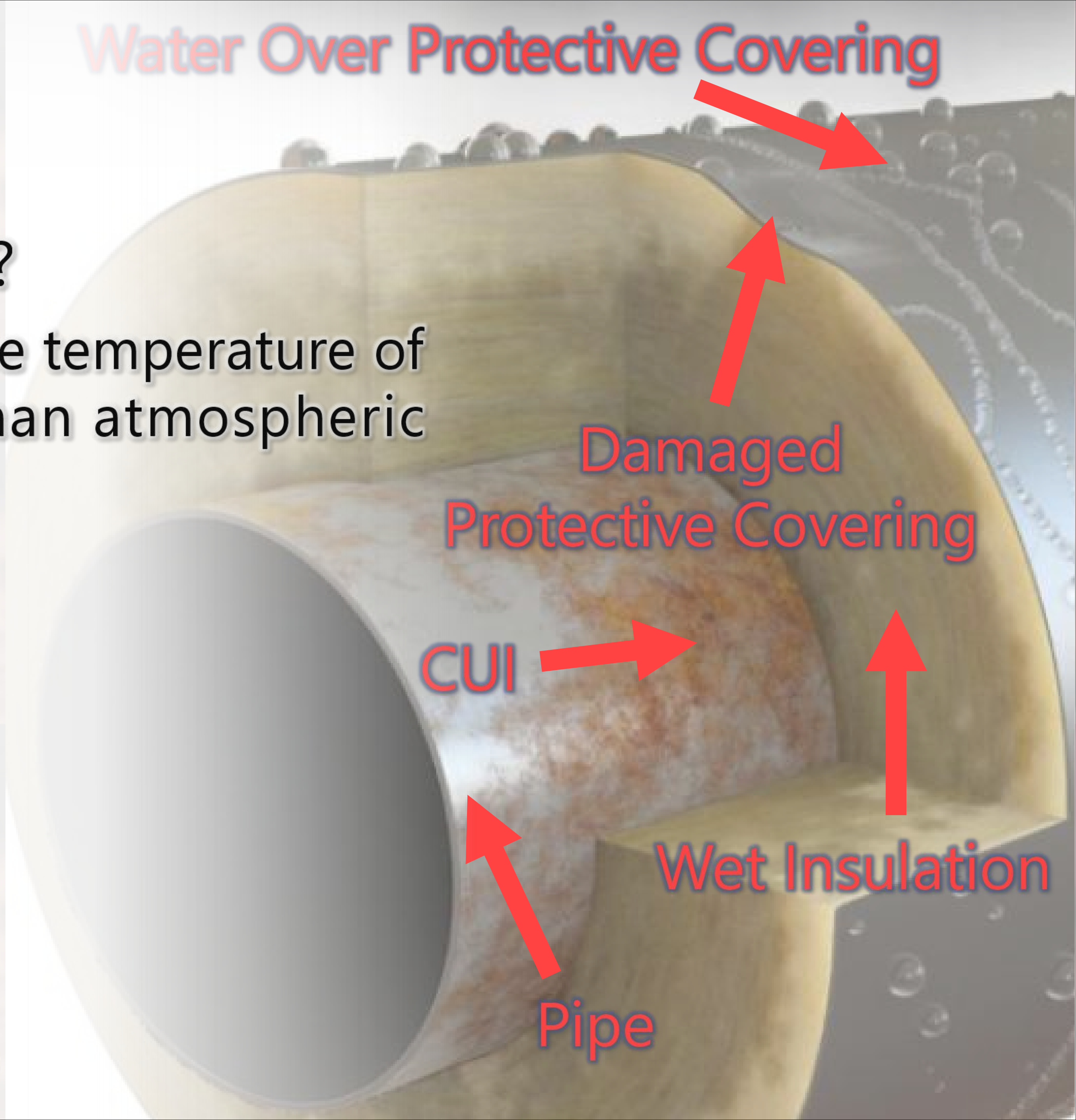
Why Does CUI Occur

- How does water enter in the insulation?
  - External water enters an insulated system primarily through breaks in the protective covering or weatherproofing.
- The protective covering breaks may be the result of the following:
  - Inadequate design
  - Improper insulation installation
  - Mechanical abuse
  - Poor maintenance practice



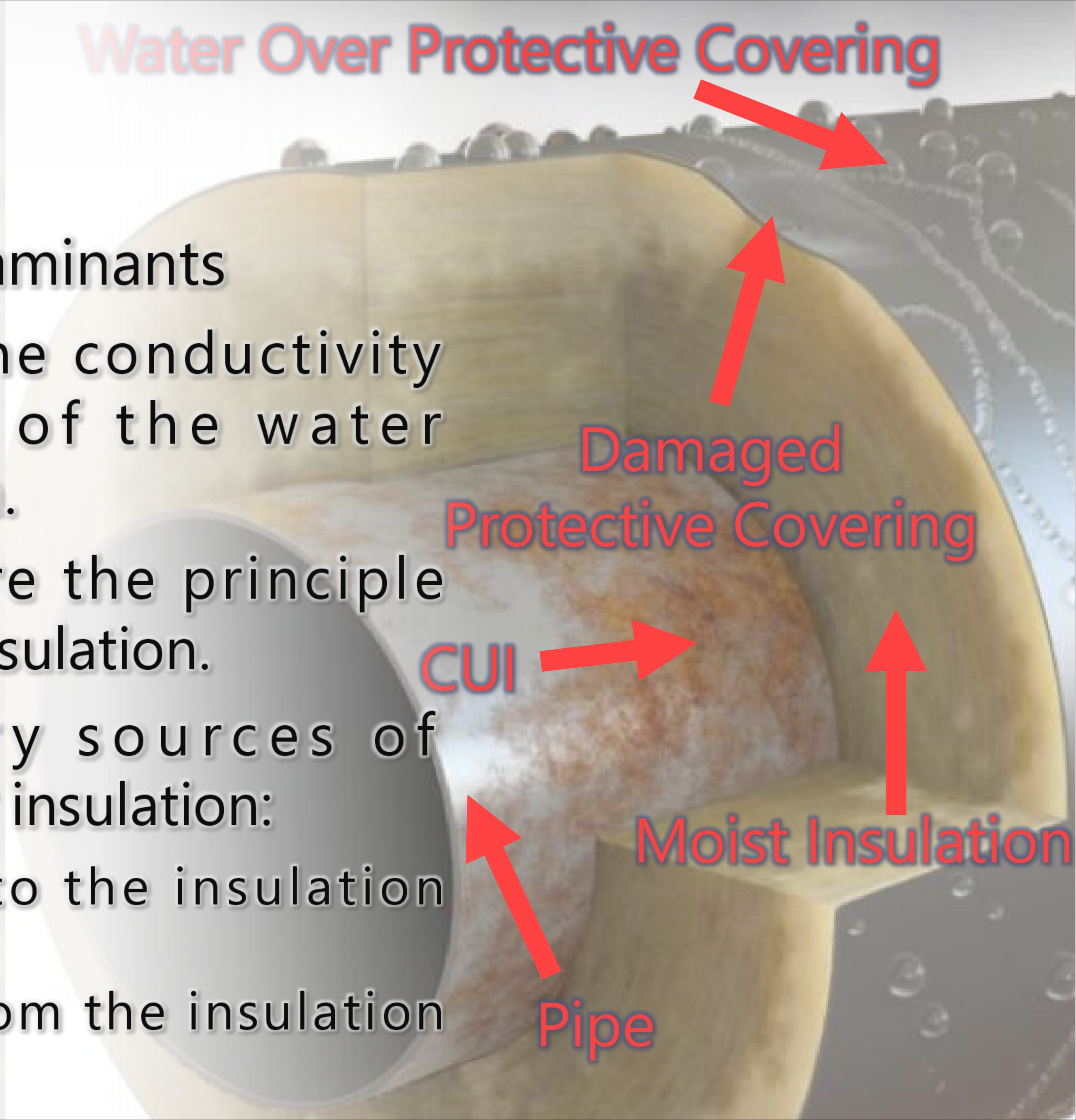
Why Does CUI Occur

- How does condensation occur?
  - Condensation results when the temperature of the metal surface is lower than atmospheric dew point.



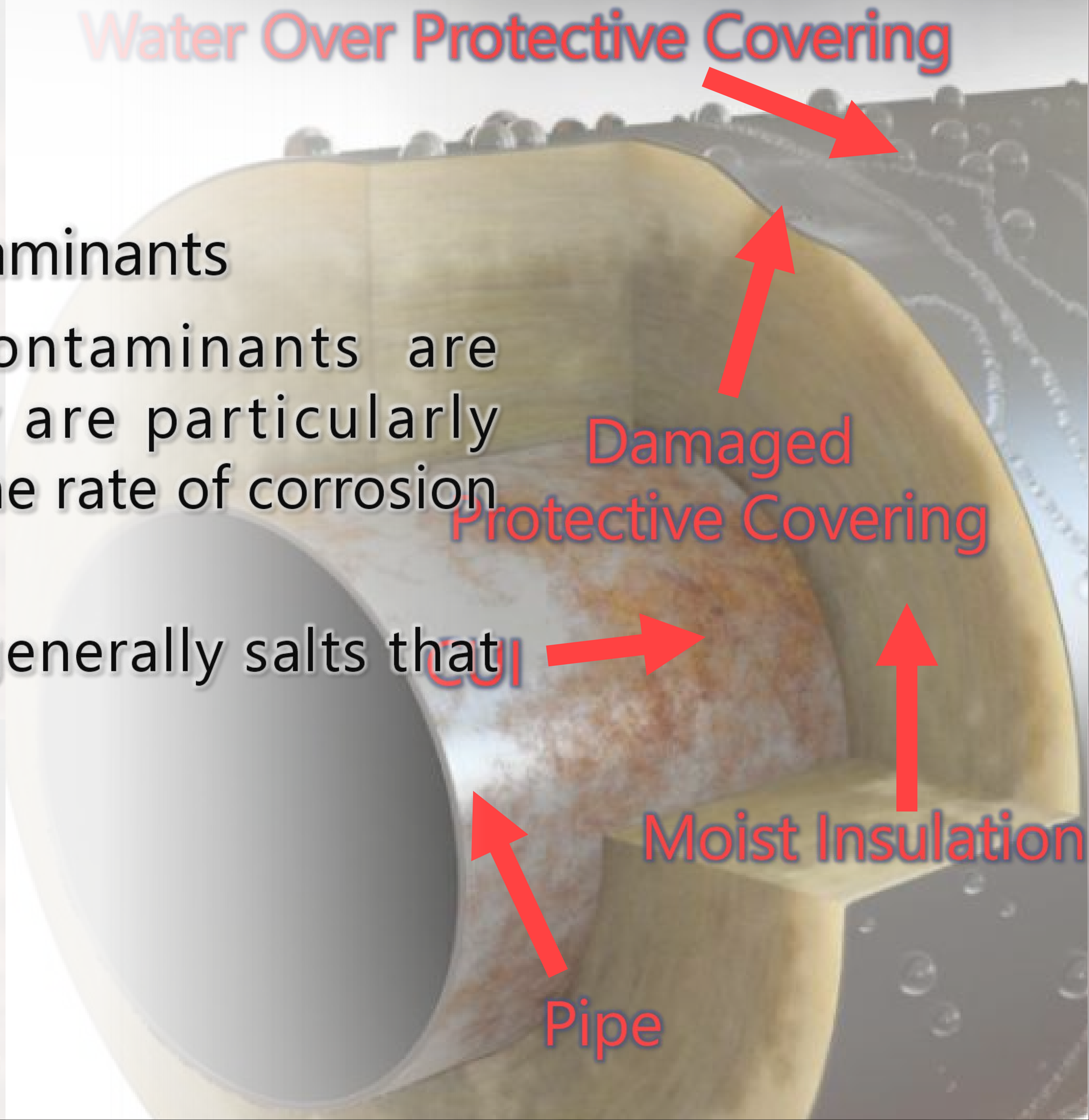
Why Does CUI Occur

- Role of the water soluble contaminants
  - Contaminants increase the conductivity and/or corrosiveness of the water environment under insulation.
  - Chlorides and sulfates are the principle contaminants found under insulation.
  - There are two primary sources of contaminants in water under insulation:
    1. Contaminants external to the insulation materials.
    2. Contaminants leached from the insulation materials and its accessories.



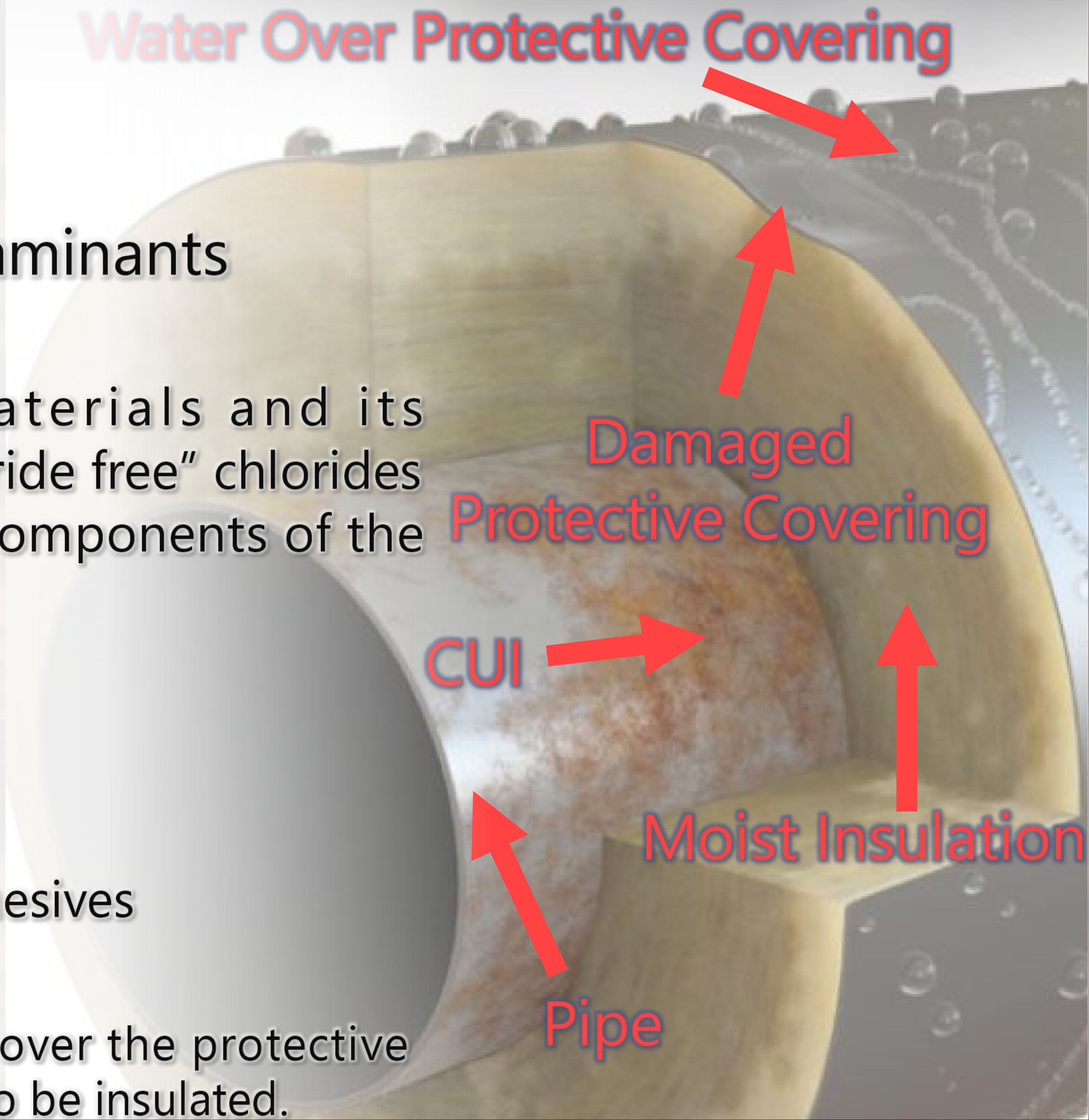
Why Does CUI Occur

- Role of the water soluble contaminants
  - Whether the sources of contaminants are external or internal, they are particularly detrimental and accelerate the rate of corrosion under insulation.
  - External contaminants are generally salts that come from sources such as:
    1. Cooling tower drift
    2. Acid rain
    3. Firewater deluge
    4. Atmospheric emissions etc.



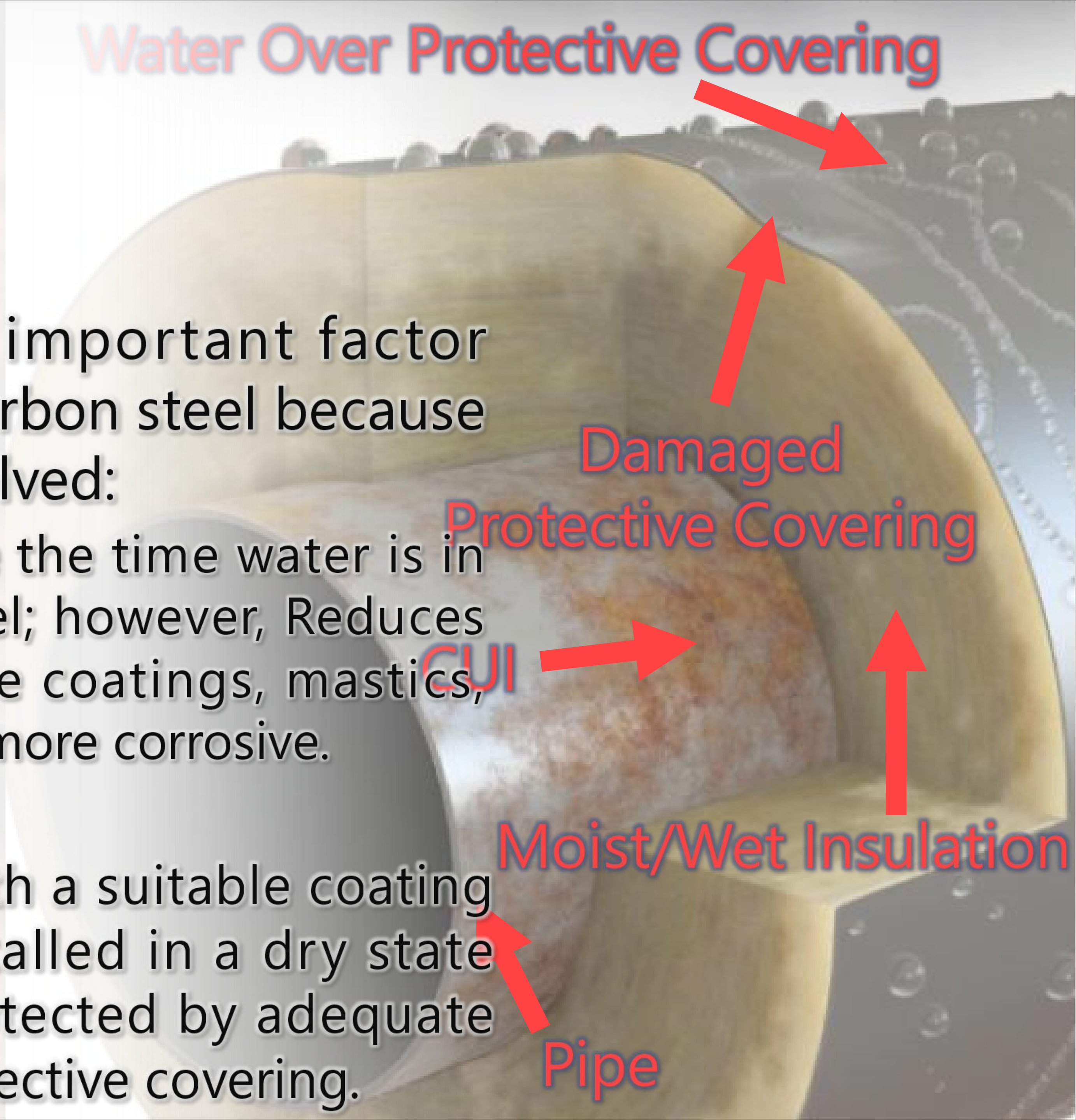
Why Does CUI Occur

- Role of the water soluble contaminants
  - Sources of Chlorides
    - Unless the insulation materials and its accessories are declared “chloride free” chlorides can be present in almost all components of the insulation system such as:
      1. Insulation materials
      2. Mastic or sealants
      3. Vapor barriers
      4. Jointing compounds and adhesives
      5. Anti abrasive coatings
  - Contaminants may also be present over the protective coating applied on the steel surface to be insulated.



Why Does CUI Occur

- Role of temperature
  - Service temperature is an important factor affecting the rate of CUI of carbon steel because two opposing factors are involved:
    - Higher temperatures reduce the time water is in contact with the carbon steel; however, Reduces the service life of protective coatings, mastics, sealants and make the water more corrosive.
- CUI is a strong possibility If:
  - Steel work is not protected with a suitable coating and the insulation is not installed in a dry state under dry conditions and protected by adequate weather-resistant cladding/protective covering.

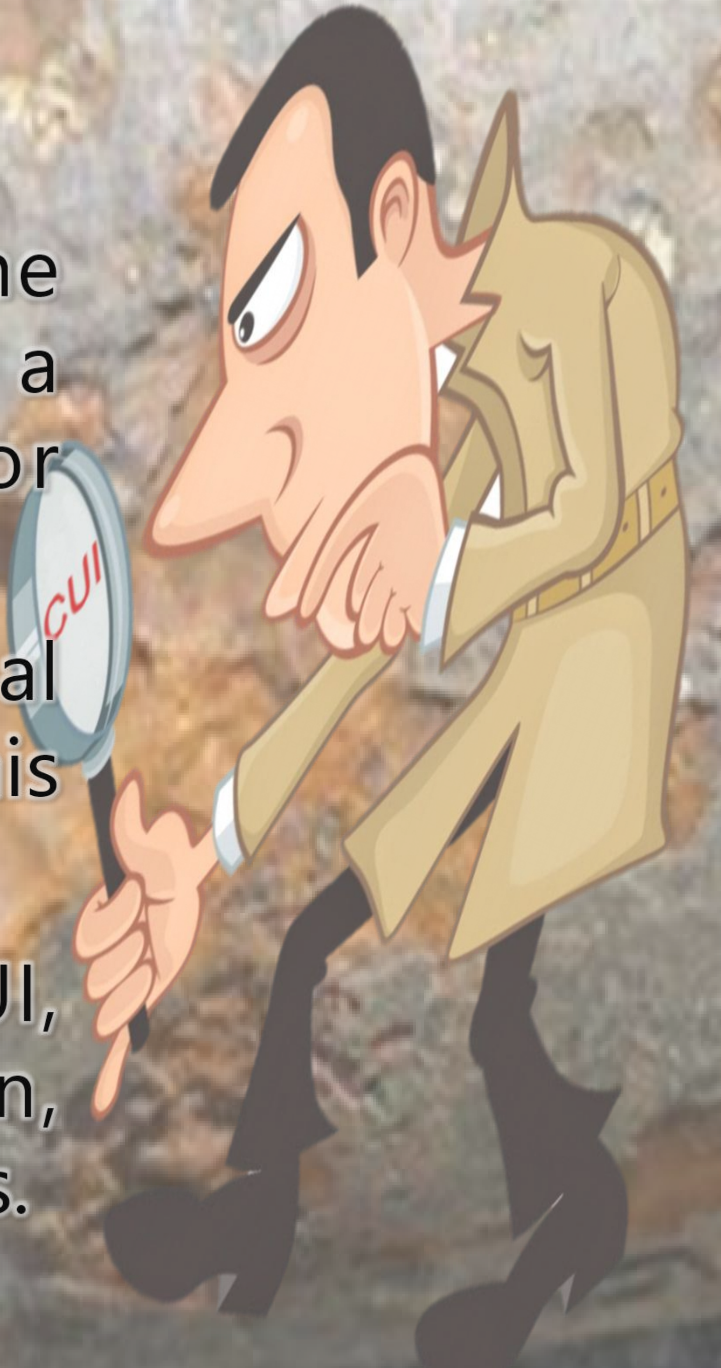


How to Detect CUI

- Detecting CUI is a multi-disciplinary work.
- Good communication and understanding is required between the group members.
- Best time to execute inspection to detect CUI is during plant shutdown period and dry season.
- Insulation is a hazardous material so proper safety supervision is also important while detecting CUI.

How to Detect CUI

- It’s a difficult task to detect and measure the effects of CUI as thermal insulation creates a formidable barrier to easy inspection for corrosion damage.
- Removing all the insulation would be the ideal method for locating and evaluating CUI, but this is time-consuming and expensive.
- Inside (indoors) areas are less at risk for CUI, provided that they are not near hose-down, safety shower, or fire protection deluge systems.



How to Detect CUI

- There are several ways of detecting CUI on piping systems.
- Detecting CUI on vessels is generally more difficult, but it is possible using some techniques.

- Before selecting a CUI detection technique or methods consideration should be given to the following:
  - Utilized metallurgy (CS, SS etc.).
  - Operating conditions.
  - Insulation and protective covering type and their thickness.

How to Detect CUI

- ❑ Following techniques are used to detect CUI:
  - Visual inspection
    - 100% insulation removal
    - Partial insulation removal
  - Nondestructive moisture and corrosion detection technique's
    - Moisture meter
    - Infrared thermography
    - Profile, flash radiography
    - Pulsed eddy current
    - Ultrasonic testing
  - Options are not limited to the techniques given here, and other techniques may also be appropriate.

How to Detect CUI

- Complete (100%) insulation removal
  - The only method that can detect 100% CUI damage.
    - The most reliable technique to detect CUI is to physically remove the insulation and visually inspect the surface damage due to CUI.
    - This approach is costly and time consuming since insulation on equipment or piping etc. must be stripped and reinstalled.
    - Scaffolding costs to access insulated areas for insulation removal, inspection and re-insulation can be significant especially for large vessels or piping systems on columns or towers.

How to Detect CUI

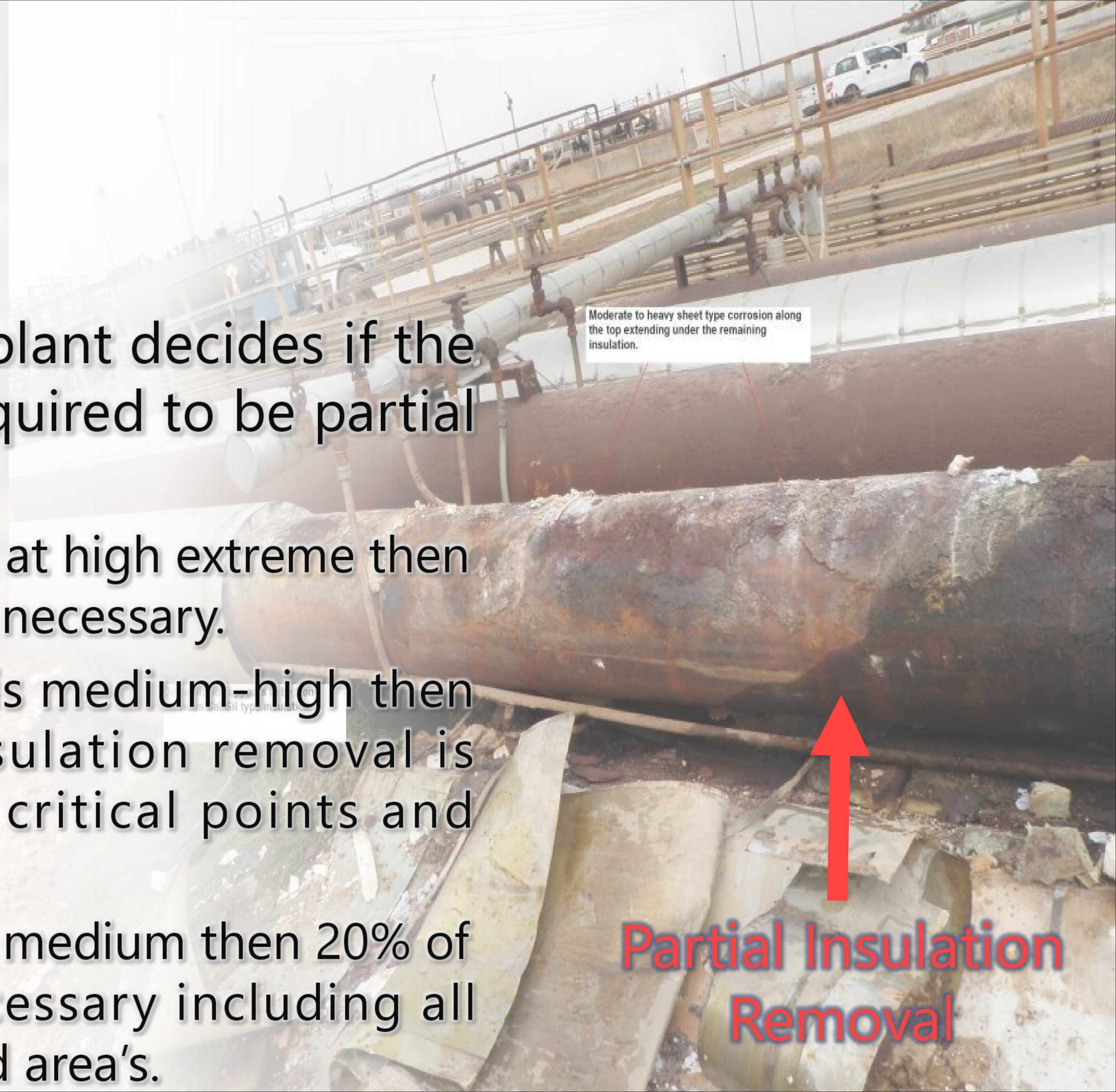
- ❑ Complete (100%) insulation removal
  - o This is a qualitative method to detect CUI that cannot directly measure the loss of metal thickness, and requires other NDT techniques such as pit gauge, ultrasonic testing or radiography to quantify metal loss.
  - o Process-related problems may also occur if the insulation is removed while the piping/equipment is in service.
    - ▪ Insulation removal and Inspection personnel may be exposed to hot surfaces and need to be careful to avoid contact with surfaces at or above 60°C.

This Method Involves

- Insulation Removal
- Check the Surface Condition
- Metal Thickness Measurement
- Rectification of the Problem Areas
- Reinsulate the Surface

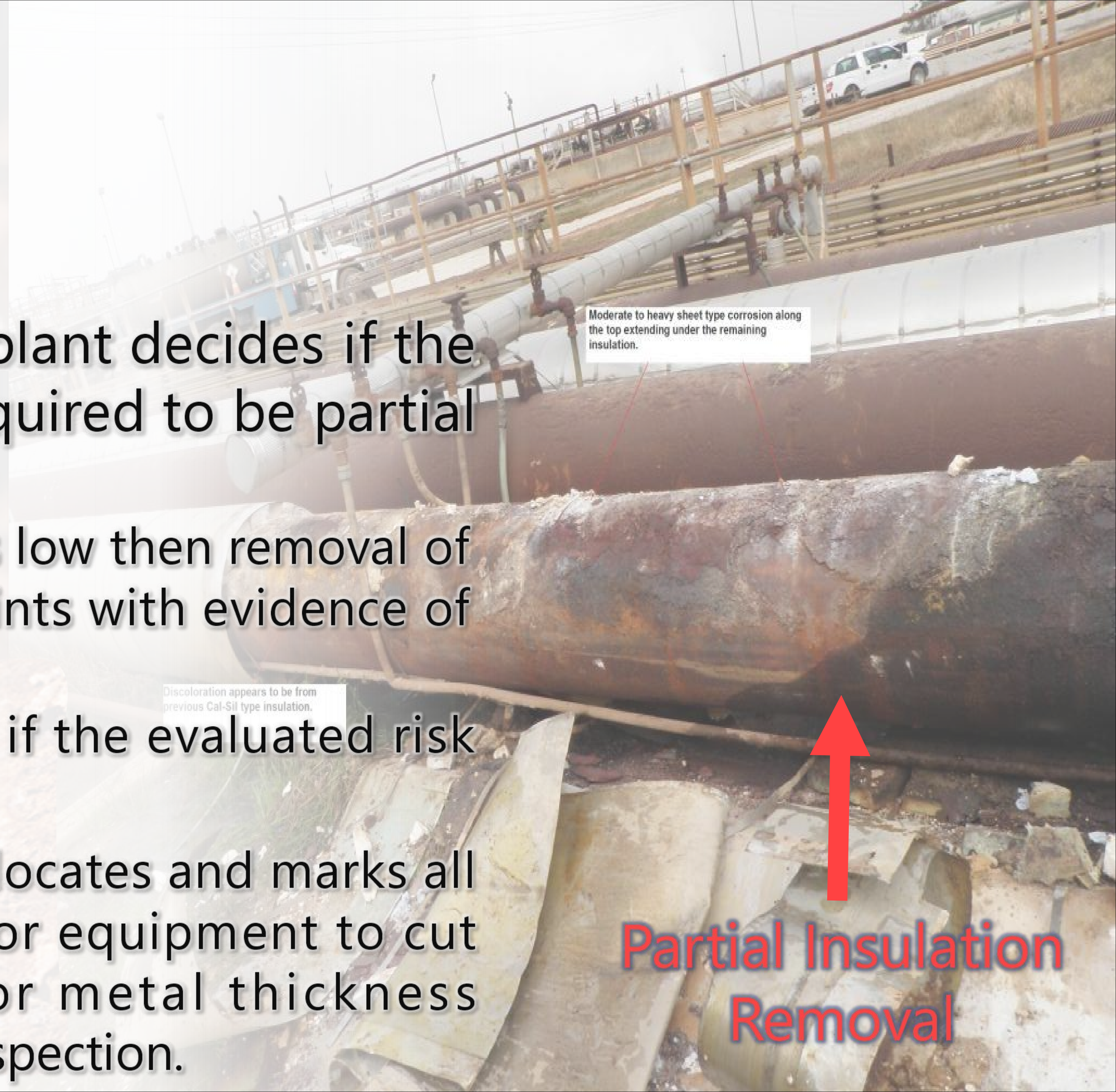
How to Detect CUI

- ☐ Partial insulation removal
  - Risk evaluation team of a plant decides if the removal of insulation is required to be partial or 100%.
    - If the evaluated risk level is at high extreme then 100% insulation removal is necessary.
    - If the evaluated risk level is medium-high then greater than 40% of insulation removal is necessary including all critical points and damaged area's.
    - If the evaluated risk level is medium then 20% of insulation removal is necessary including all critical points and damaged area's.


Moderate to heavy sheet type corrosion along the top extending under the remaining insulation.
Partial Insulation Removal

How to Detect CUI

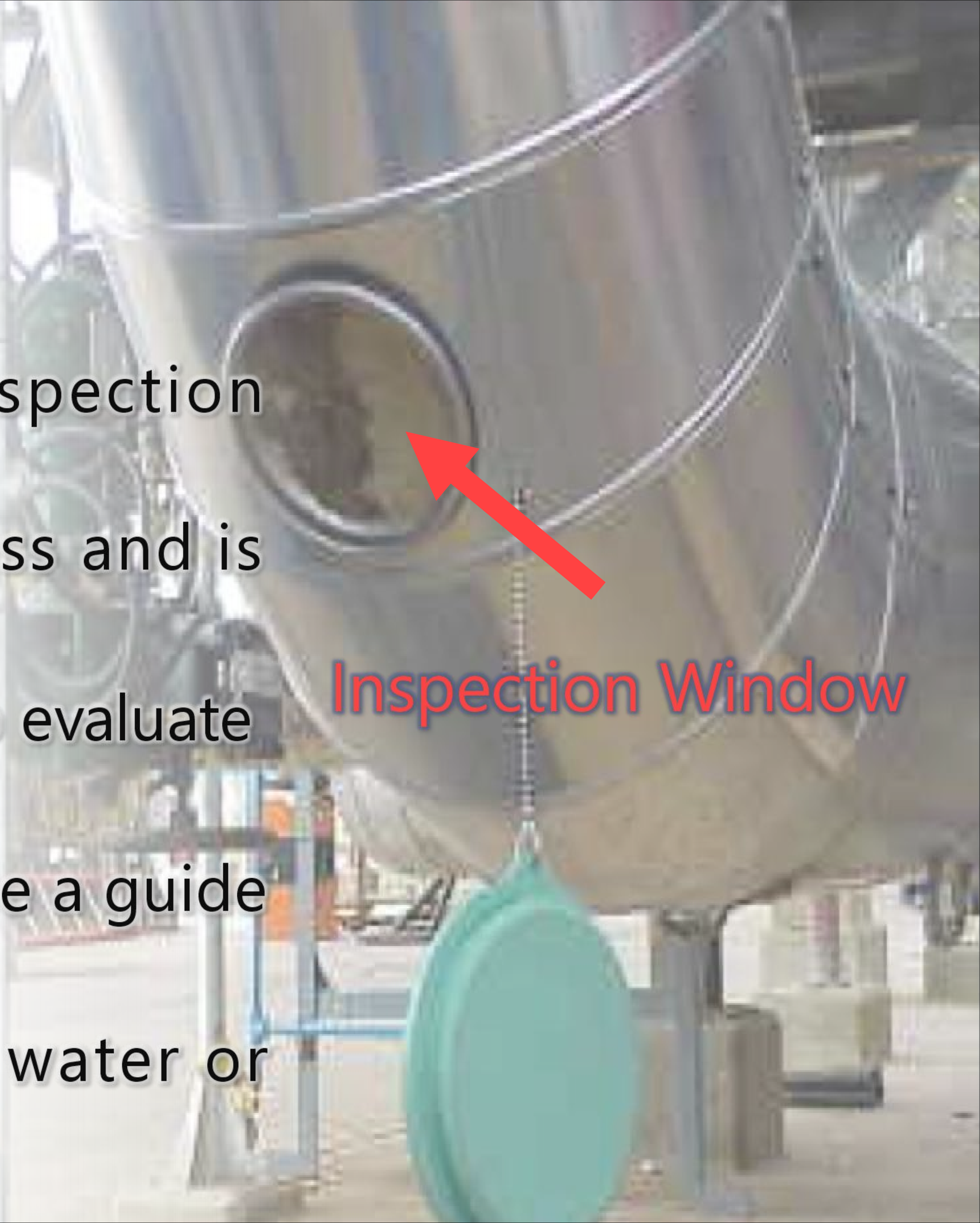
- Partial insulation removal
  - Risk evaluation team of a plant decides if the removal of insulation is required to be partial or 100%.
    - If the evaluated risk level is low then removal of insulation at all critical points with evidence of damage is necessary.
    - No inspection is required if the evaluated risk level is negligible.
    - Risk evaluation team also locates and marks all critical areas of a piping or equipment to cut inspection openings for metal thickness measurement and visual inspection.


Moderate to heavy sheet type corrosion along the top extending under the remaining insulation.
Discoloration appears to be from previous Cal-Sil type insulation.
Partial Insulation Removal

How to Detect CUI

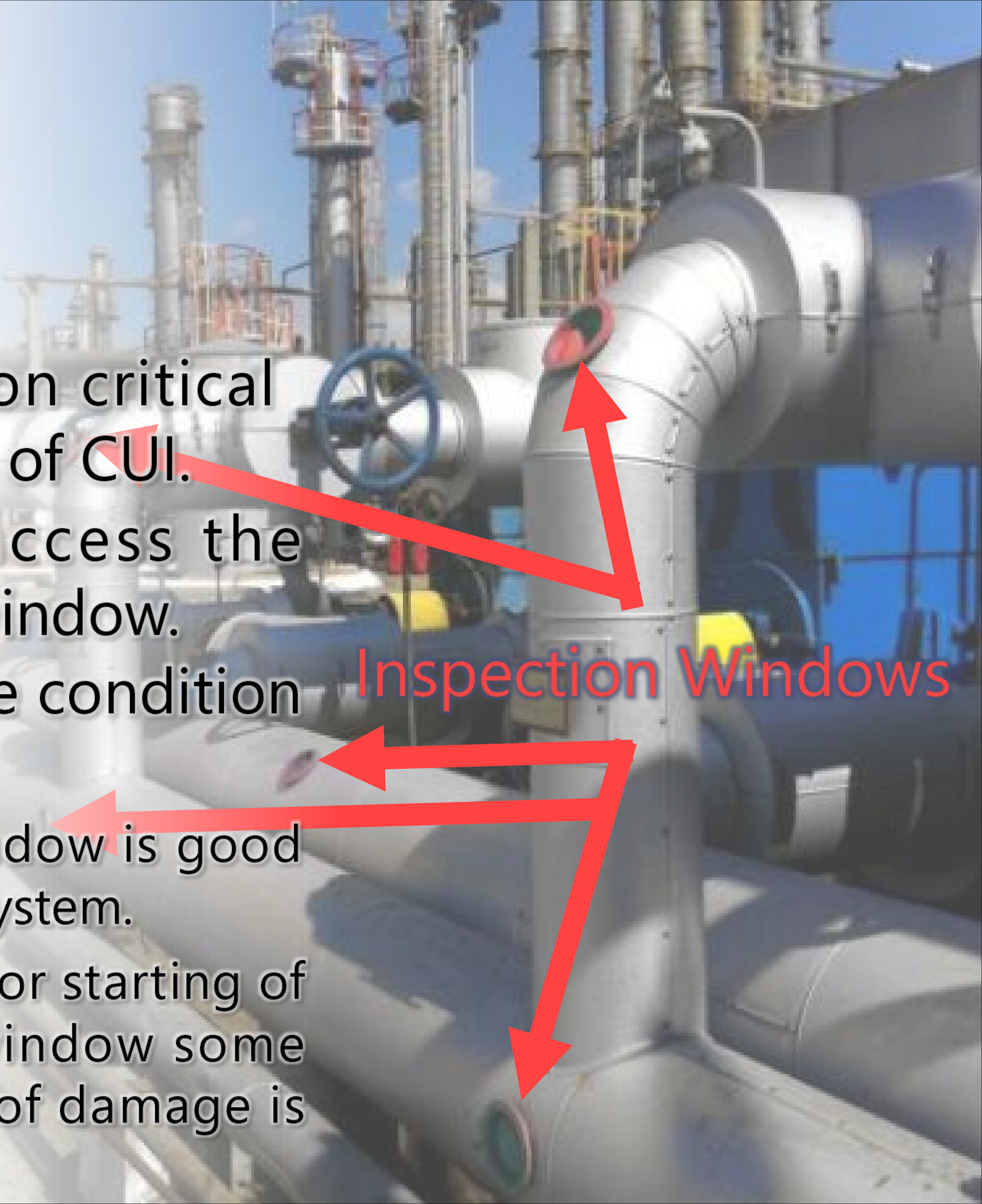
❑ Inspection openings

- CUI may be detected through inspection openings/windows.
- Generally carried out as a first pass and is usually limited by access.
- The technique requires a little cost to evaluate CUI initially.
- Only covers small area's that provide a guide to potential problem area's.
- The windows can be a source of water or moisture ingress.



How to Detect CUI

- Inspection openings
  - Inspection windows are installed on critical locations where there is a possibility of CUI.
  - The openings are removed to access the condition of the surface under the window.
  - Special consideration is given on the condition of the coating under insulation.
    - If the coating under the inspection window is good then it is an indication of less CUI in the system.
    - If there is indication of coating damage or starting of general corrosion under inspection window some insulation can be removed and extent of damage is determined to repair.



How to Detect CUI

- ❑ Nondestructive (NDT) moisture and corrosion detection technique’s
    - When insulation removal is not practical, suitable NDT methods are used for detecting CUI.
    - Selecting an NDT technique for detecting CUI requires detailed knowledge of the piping system or equipment layout as well as advantages and disadvantages with a cost to benefit ratio.
    - It is also recommended to hire a trained and certified NDT technician(s) to detect CUI of a piping or equipment.

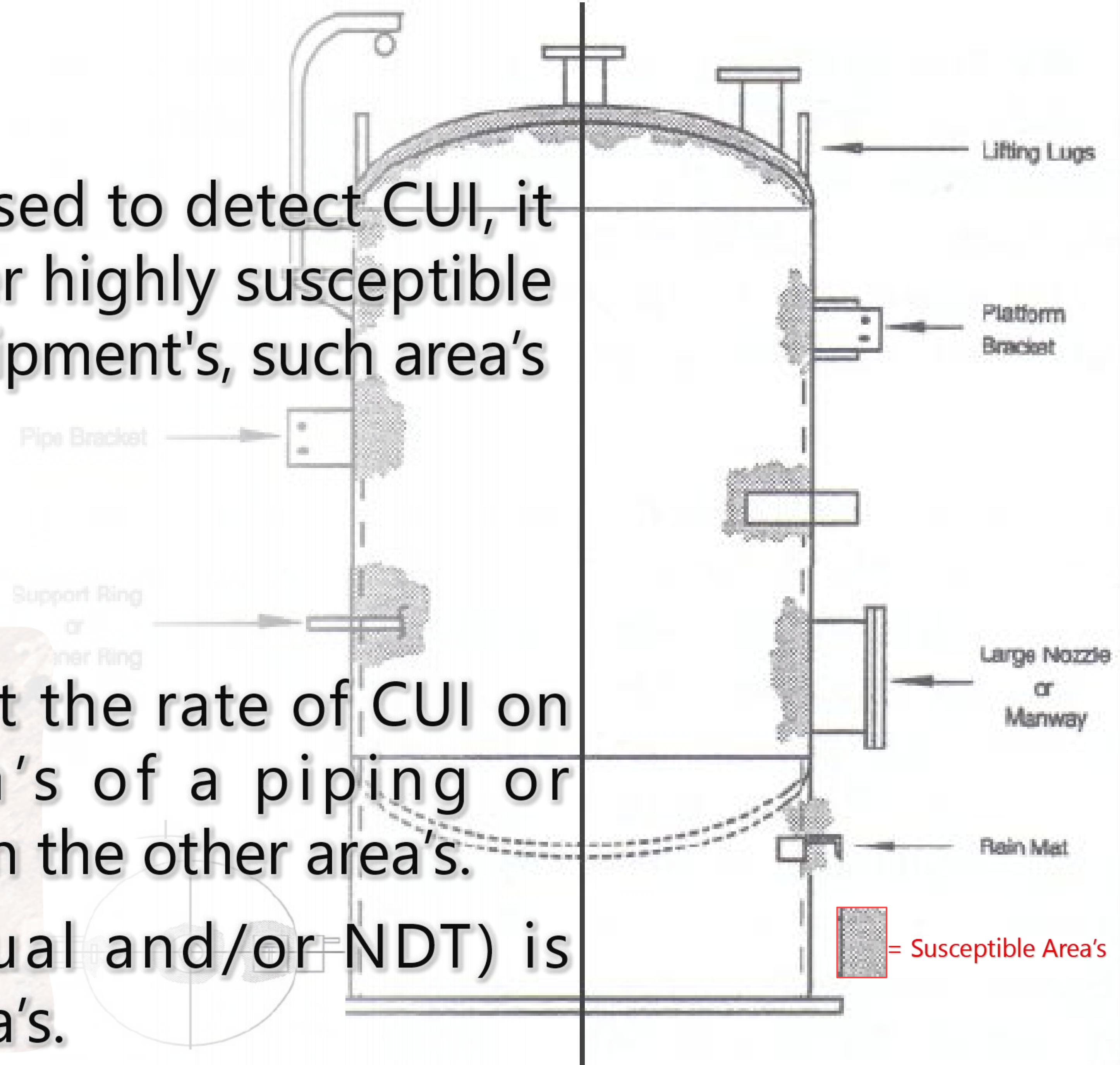
This Method Involves

- NDT Examination
- Metal Thickness Measurement
- Insulation Removal if CUI is Detected
- Rectification of the Problem Areas
- Reinsulate the Surface

How to Detect CUI

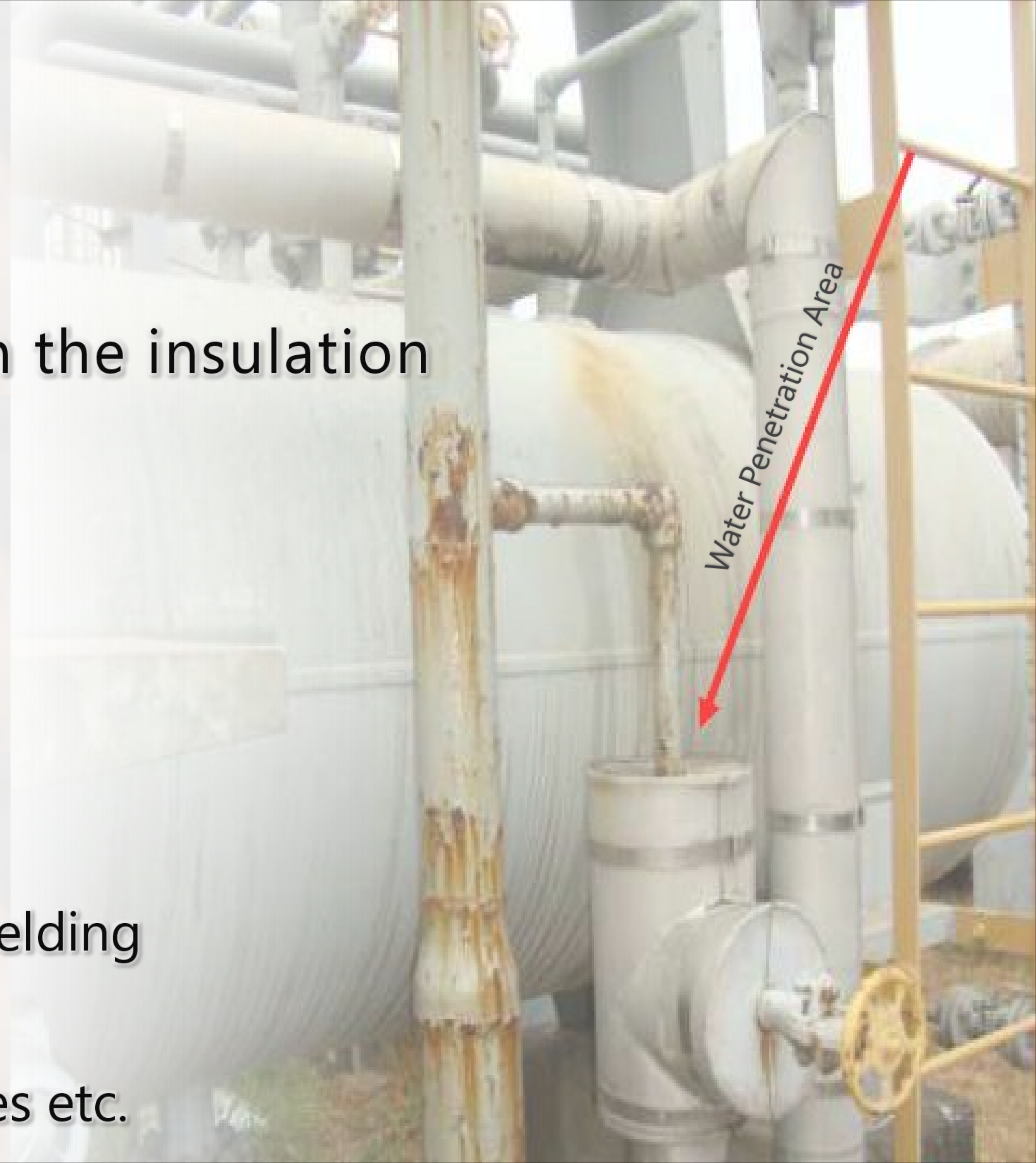
How to Detect CUI

- Regardless the method(s) used to detect CUI, it is also necessary to consider highly susceptible CUI area’s of a piping or equipment's, such area’s can be:
    - Water penetration area’s
    - Damaged insulation area’s
- Experience has shown that the rate of CUI on these susceptible area’s of a piping or equipment’s are greater than the other area’s.
- Periodic inspection (Visual and/or NDT) is recommended on these area’s.



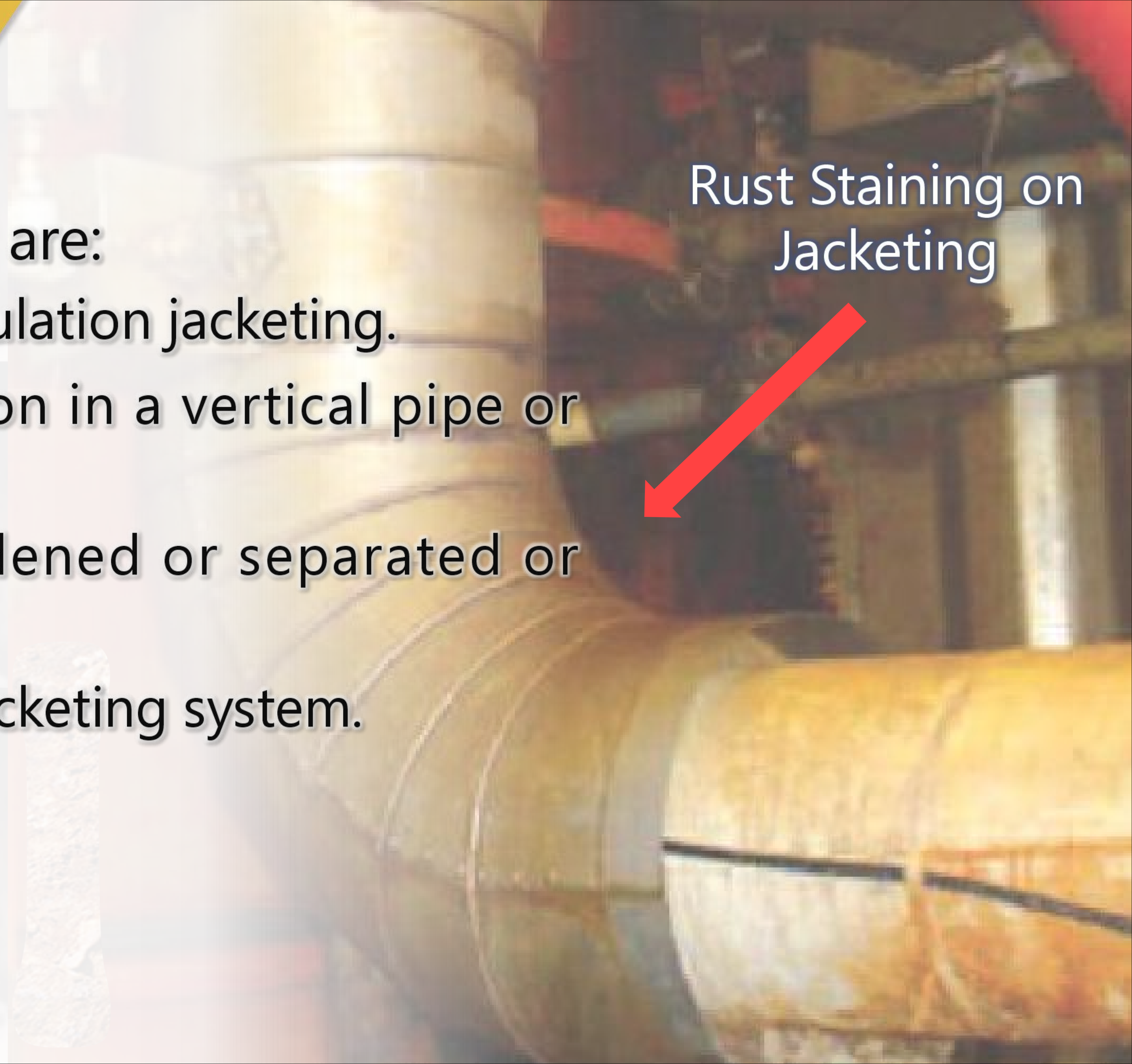
How to Detect CUI

- Water penetration area's
  - All penetrations or breaches in the insulation jacketing systems such as:
    - Dead legs
    - Hangers and other supports
    - Valves and fittings
    - Bolted-on pipe shoes
    - Ladders and platforms
    - Vessel name plates attached by welding
    - Steam tracer tubing penetrations
    - Termination of insulation at flanges etc.



How to Detect CUI

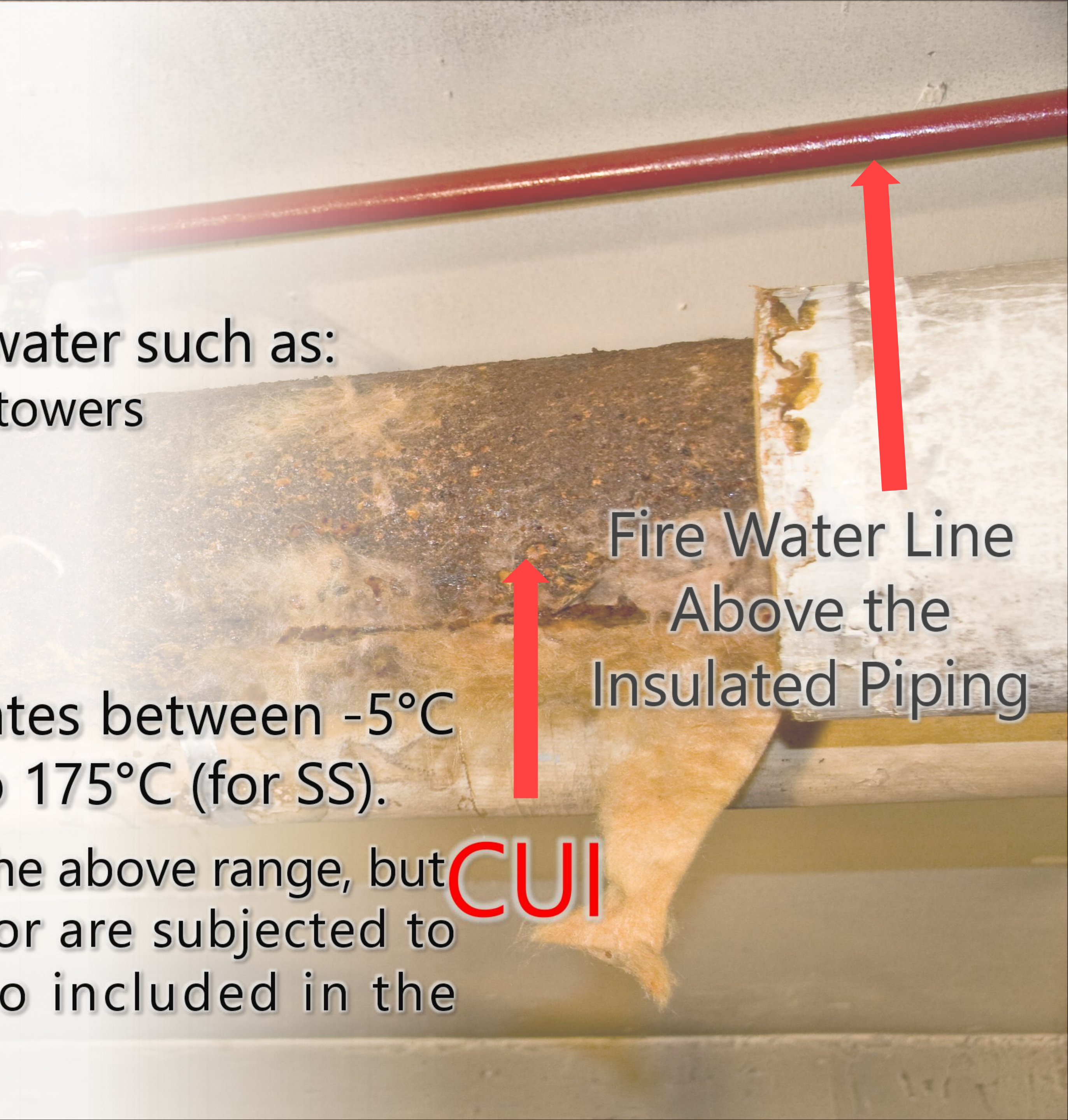
- Damaged insulation areas are:
  - Damaged or missing insulation jacketing.
  - Termination of insulation in a vertical pipe or piece of equipment.
  - Caulking that has hardened or separated or missing.
  - Bulges, staining of the jacketing system.



Rust Staining on Jacketing

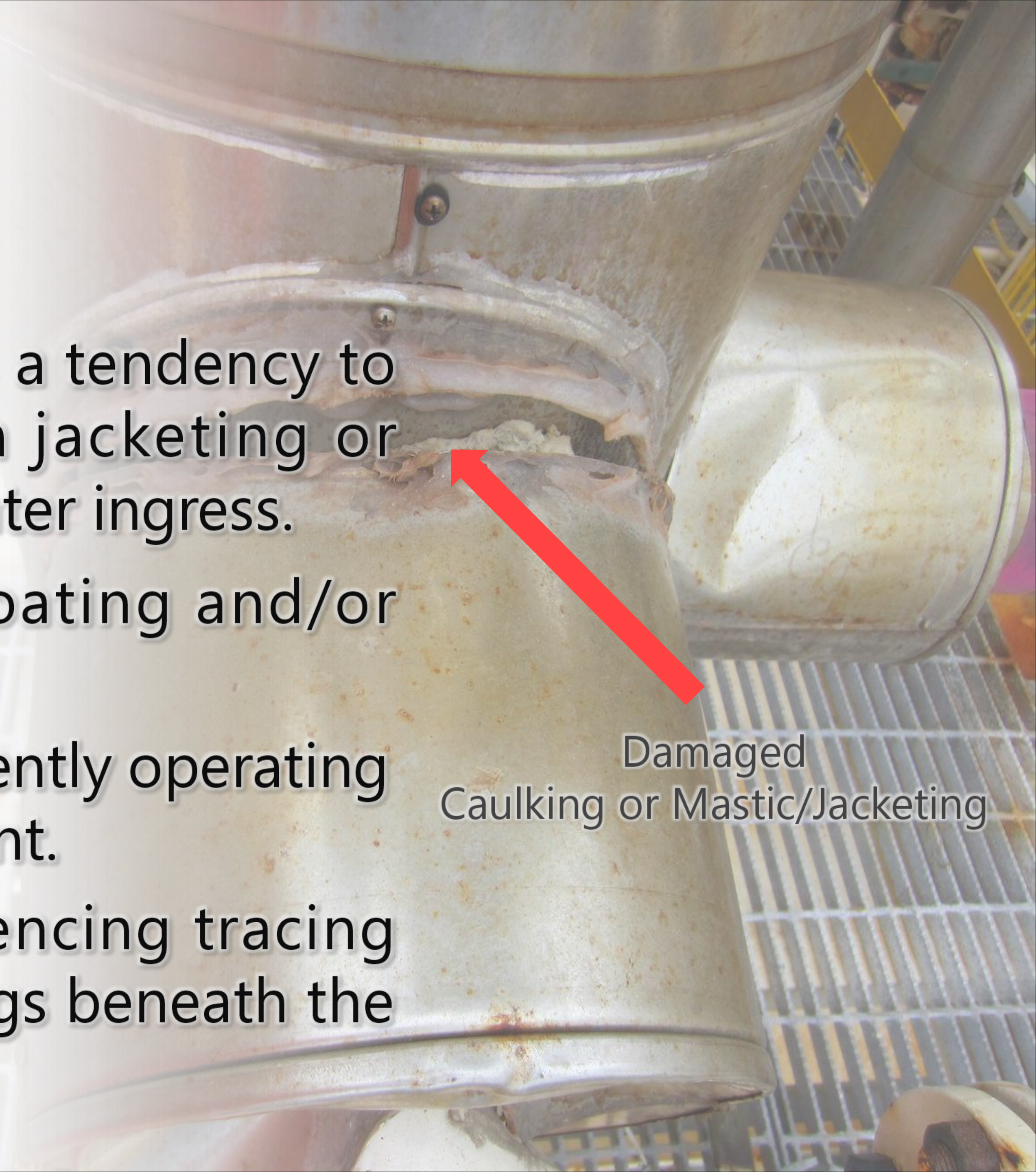
How to Detect CUI

- ☐ Other area's susceptible to CUI
  - Area's exposed to source of water such as:
    - Mist overspray from cooling towers
    - To steam vents
    - To deluge systems
    - To process spills etc.
  - Systems that normally operates between -5°C to 175°C (for CS) and 50°C to 175°C (for SS).
    - Services that are outside of the above range, but are in intermittent service or are subjected to frequent outages are also included in the susceptible to CUI.



How to Detect CUI

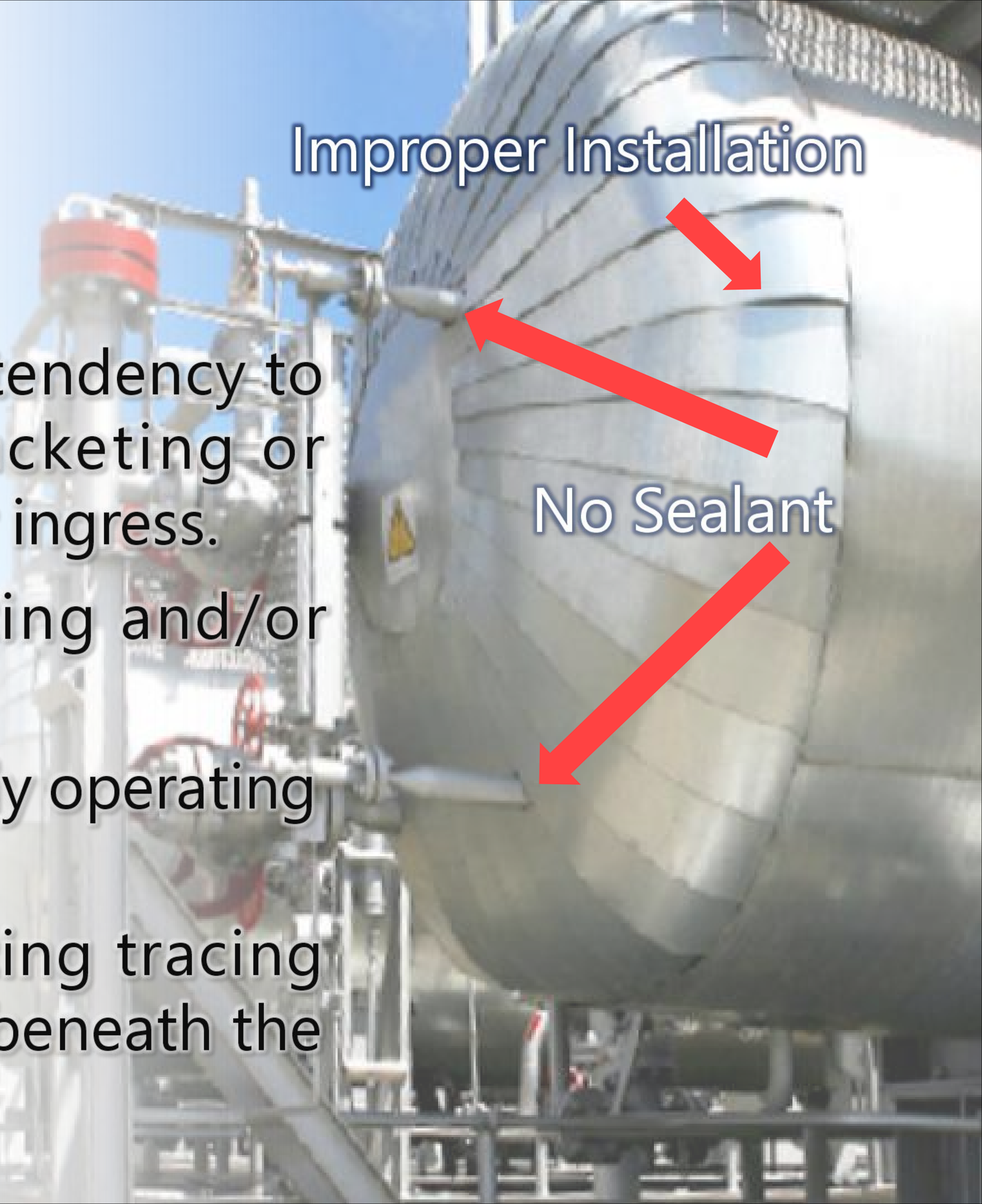
- Other area’s susceptible to CUI
    - Systems in which vibration has a tendency to inflict damage on insulation jacketing or caulking, providing paths for water ingress.
    - Systems with deteriorated coating and/or wrapping.
    - Cold service equipment consistently operating below the atmospheric dew point.
    - Steam-traced systems experiencing tracing leaks, especially at tubing fittings beneath the insulation.



Damaged
Caulking or Mastic/Jacketing

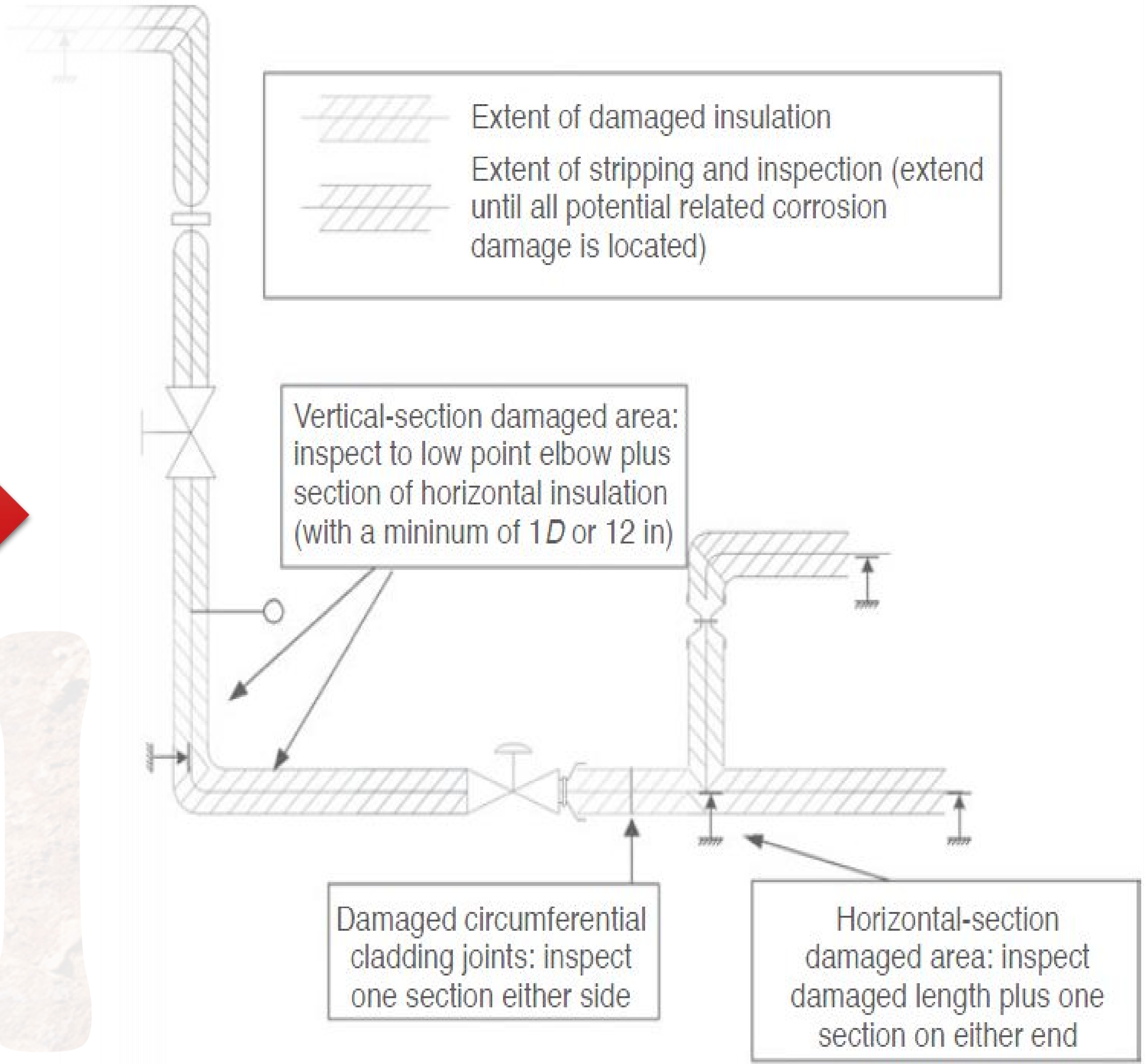
How to Detect CUI

- Other area’s susceptible to CUI
  - Systems in which vibration has a tendency to inflict damage on insulation jacketing or caulking, providing paths for water ingress.
  - Systems with deteriorated coating and/or wrapping.
  - Cold service equipment consistently operating below the atmospheric dew point.
  - Steam-traced systems experiencing tracing leaks, especially at tubing fittings beneath the insulation.



How to Detect CUI

Example of Piping Areas of Concern



▨ Extent of damaged insulation

▨ Extent of stripping and inspection (extend until all potential related corrosion damage is located)

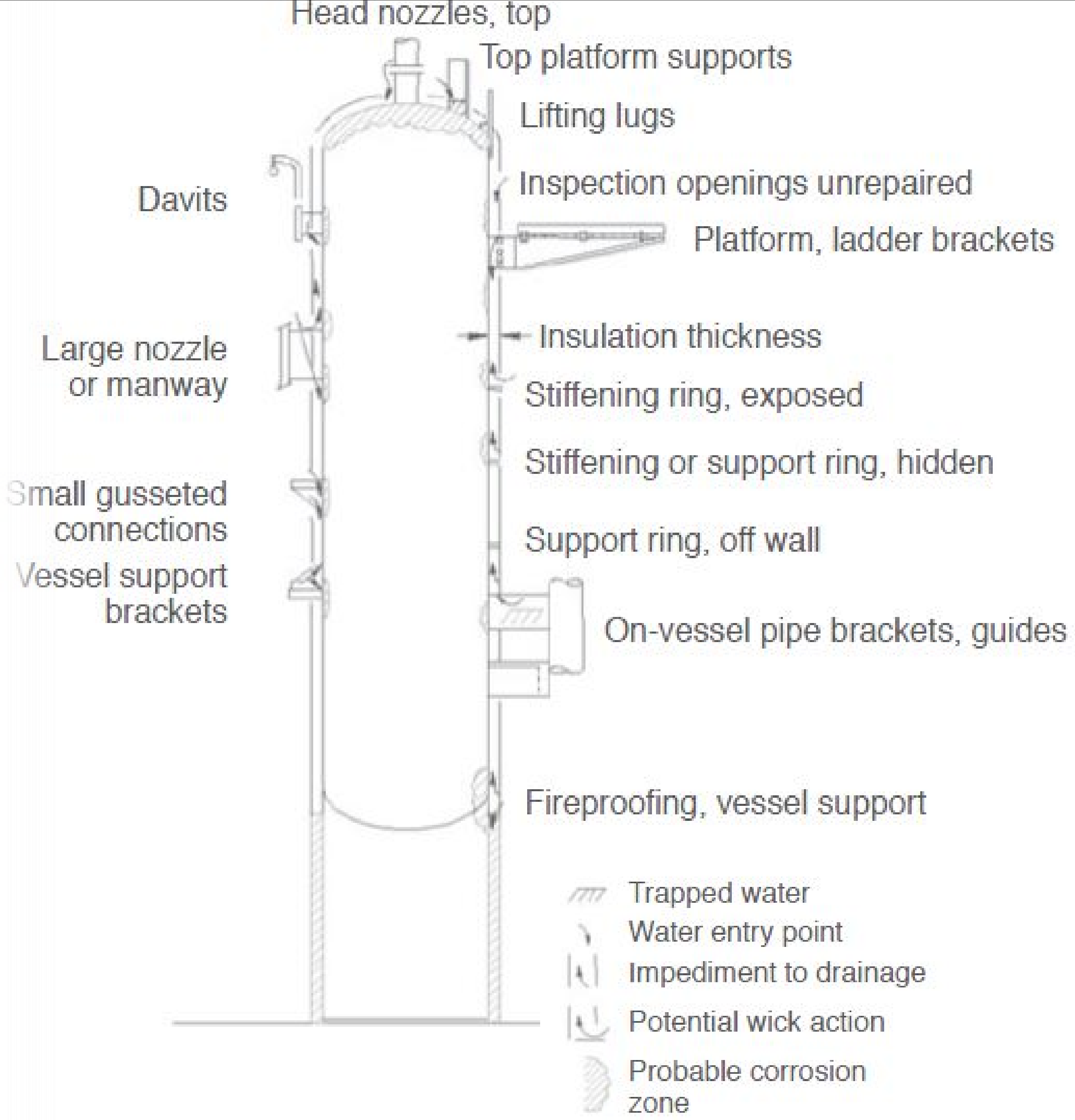
Vertical-section damaged area: inspect to low point elbow plus section of horizontal insulation (with a mininum of 1*D* or 12 in)

Damaged circumferential cladding joints: inspect one section either side

Horizontal-section damaged area: inspect damaged length plus one section on either end

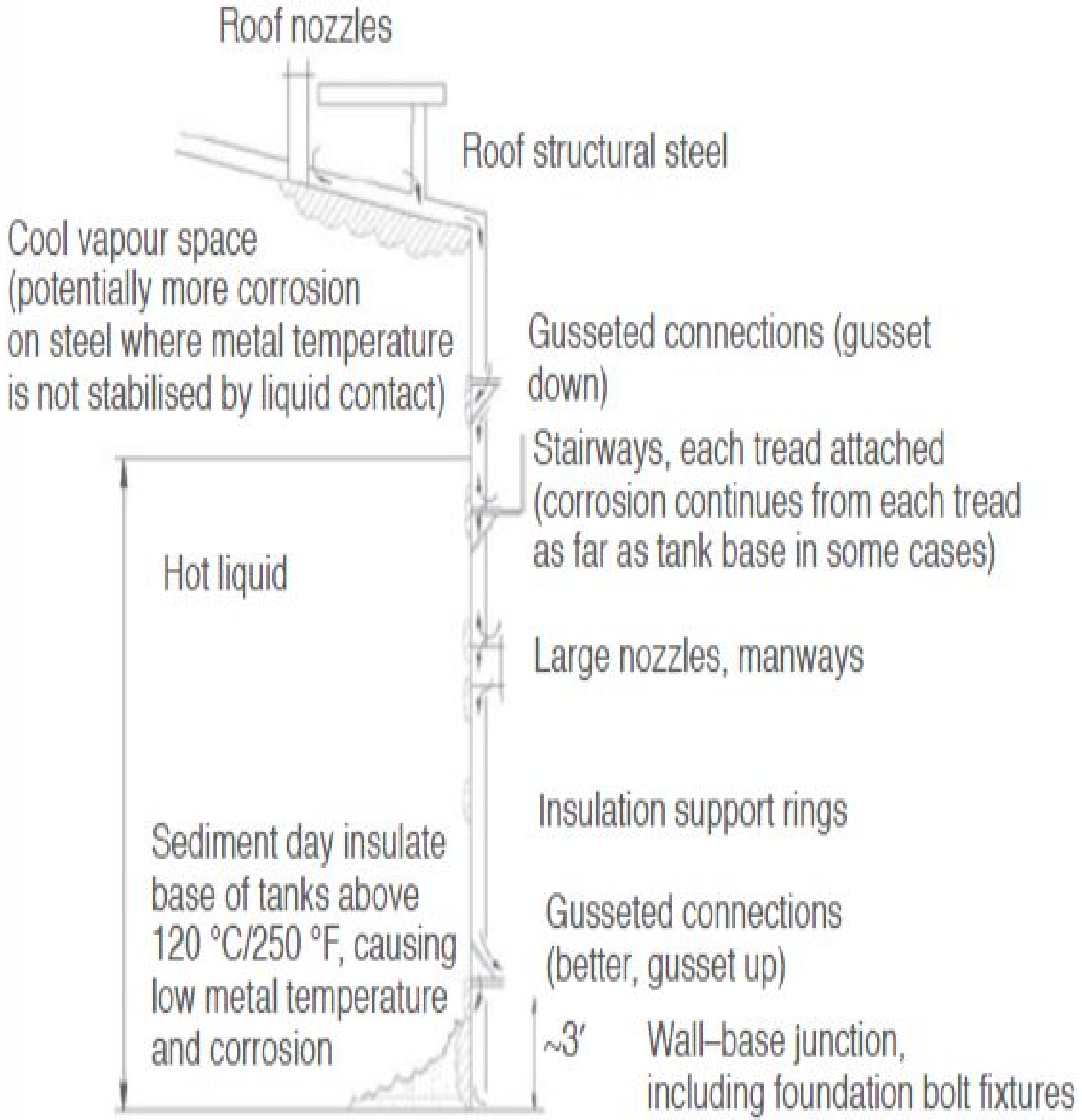
How to Detect CUI

Example of Vessel Areas of Concern



How to Detect CUI

Example of Tank Areas of Concern



Roof nozzles

Roof structural steel

Cool vapour space (potentially more corrosion on steel where metal temperature is not stabilised by liquid contact)

Gusseted connections (gusset down)

Stairways, each tread attached (corrosion continues from each tread as far as tank base in some cases)

Hot liquid

Large nozzles, manways

Insulation support rings

Sediment day insulate base of tanks above 120 °C/250 °F, causing low metal temperature and corrosion

Gusseted connections (better, gusset up)

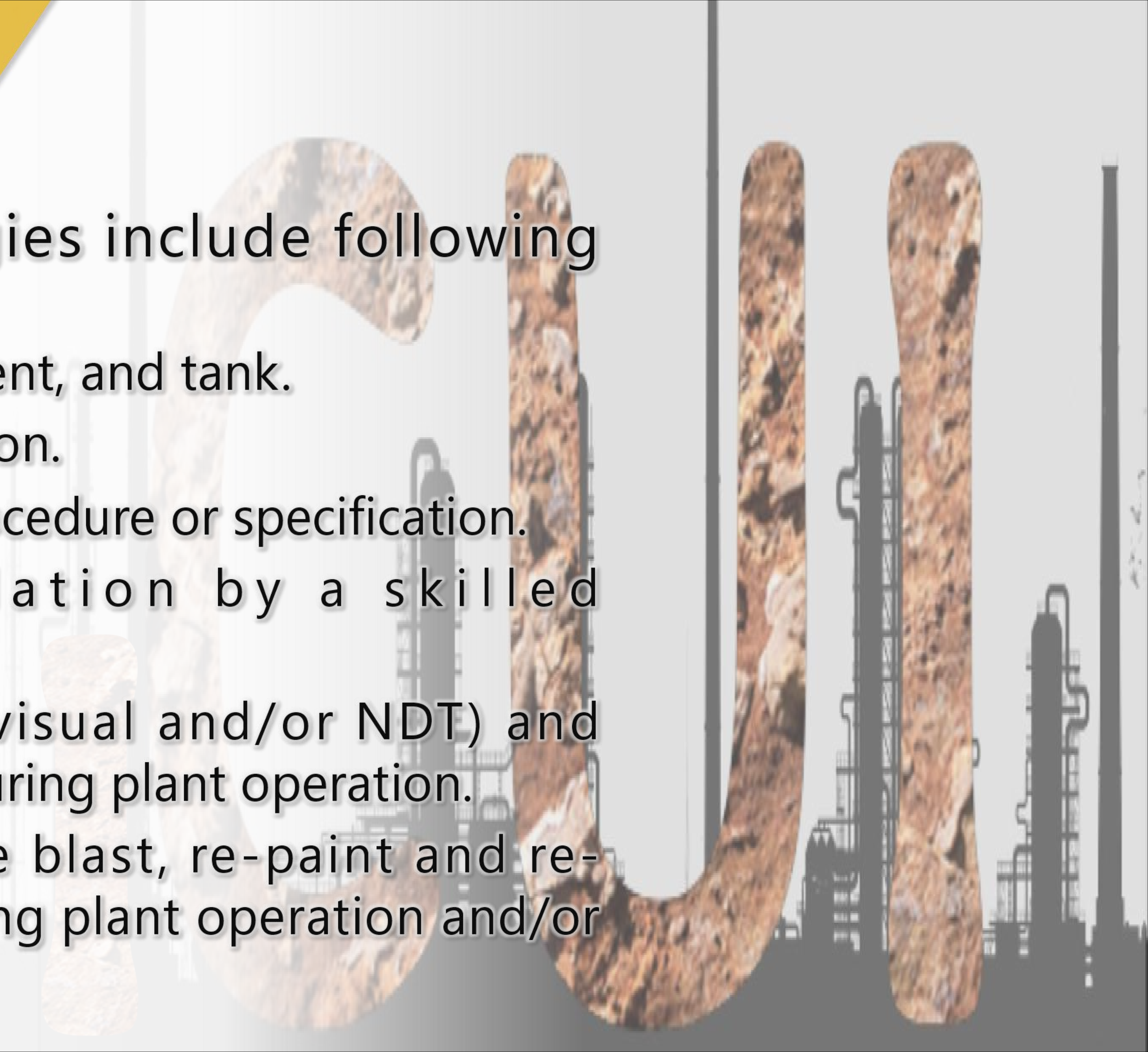
~3′

Wall–base junction, including foundation bolt fixtures

How to Prevent CUI

- To prevent CUI, a lot of prevention strategies are required to be taken from the design stage through construction, plant operation, to shutdown a plant.
- CUI prevention strategies provide long term and reliable prevention of CUI that move towards free from “un-necessary shutdowns”, “un-expected maintenance”, “catastrophic failure” of the systems and significant maintenance cost reductions.

How to Prevent CUI



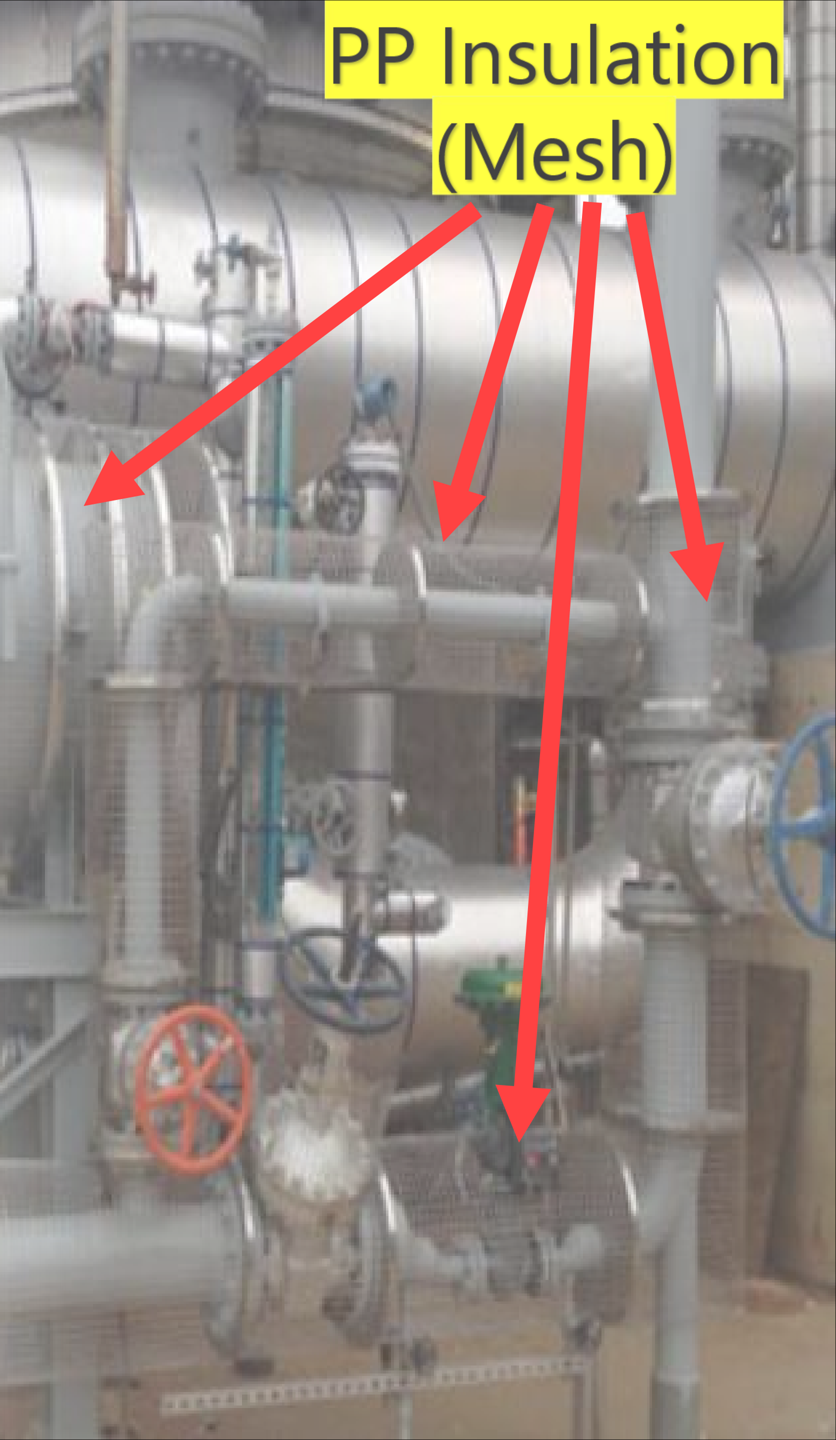
- CUI prevention strategies include following elements:
  1. Design – piping, equipment, and tank.
  2. Protective coating selection.
  3. Insulation installation procedure or specification.
  4. Insulation installation by a skilled craftmanship/contractor.
  5. Ongoing inspection (visual and/or NDT) and maintenance practices during plant operation.
  6. Periodic strip, abrasive blast, re-paint and re-insulate the system during plant operation and/or shutdown.

How to Prevent CUI

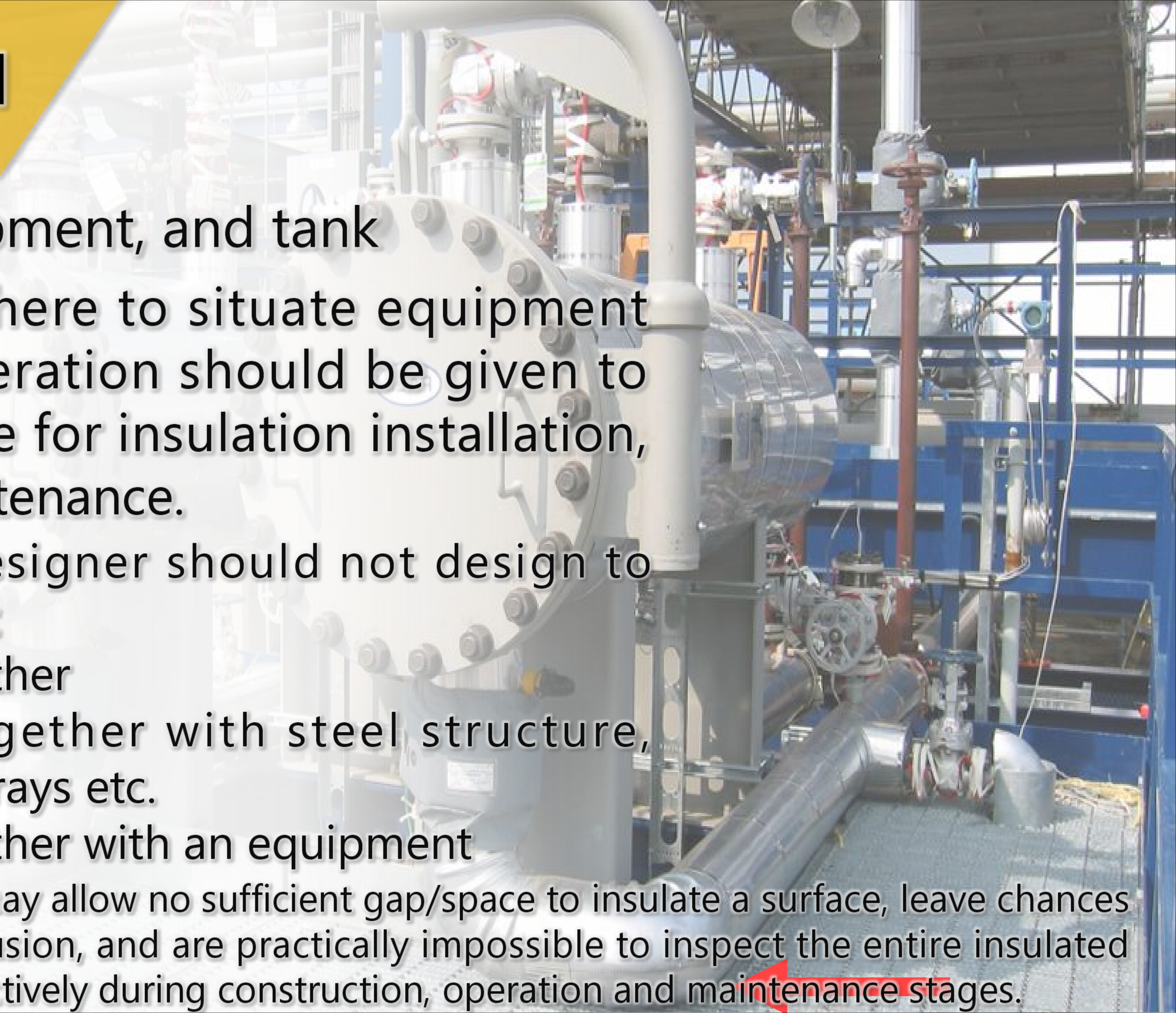
- Design – piping, equipment, and tank
    - Equipment and piping design has an important influence on CUI.
    - If proper consideration is given to CUI at the design stage it may be possible to eliminate corrosion altogether, or at least to limit the potential for CUI and Cl-ESCC.

How to Prevent CUI

- Design – piping, equipment, and tank
  - The best way of avoiding CUI is not to insulate a piping or equipment at all.
  - The above statement is not always practical saying not to insulate a surface when a surface must be insulated for: heat conservation, process stabilization, preventing freezing, reduce noise pollution, and personal protection etc.
  - But, where insulation is required only for personal protection (PP) it is recommended to fit metal guards/mesh rather than insulation.



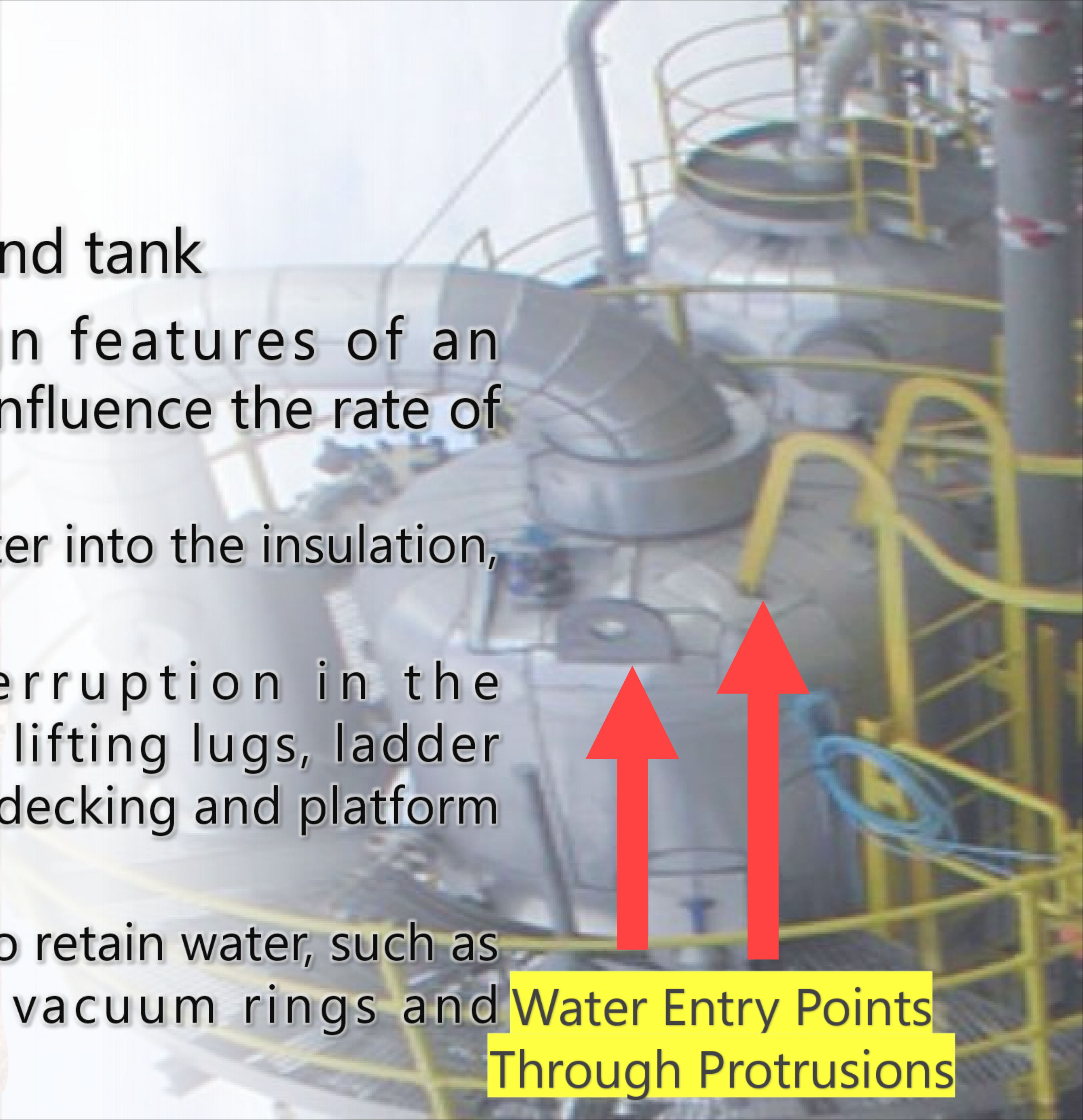
How to Prevent CUI



- ❑ Design – piping, equipment, and tank
  - When designing where to situate equipment and piping, consideration should be given to allow effective space for insulation installation, inspection and maintenance.
    - For example, a designer should not design to install/situate pipes:
      - ✓ Too closed together
      - ✓ Too closed together with steel structure, gratings, cable trays etc.
      - ✓ Too closed together with an equipment
    - Above design problems may allow no sufficient gap/space to insulate a surface, leave chances of water or moisture intrusion, and are practically impossible to inspect the entire insulated surface and maintain effectively during construction, operation and maintenance stages.

How to Prevent CUI

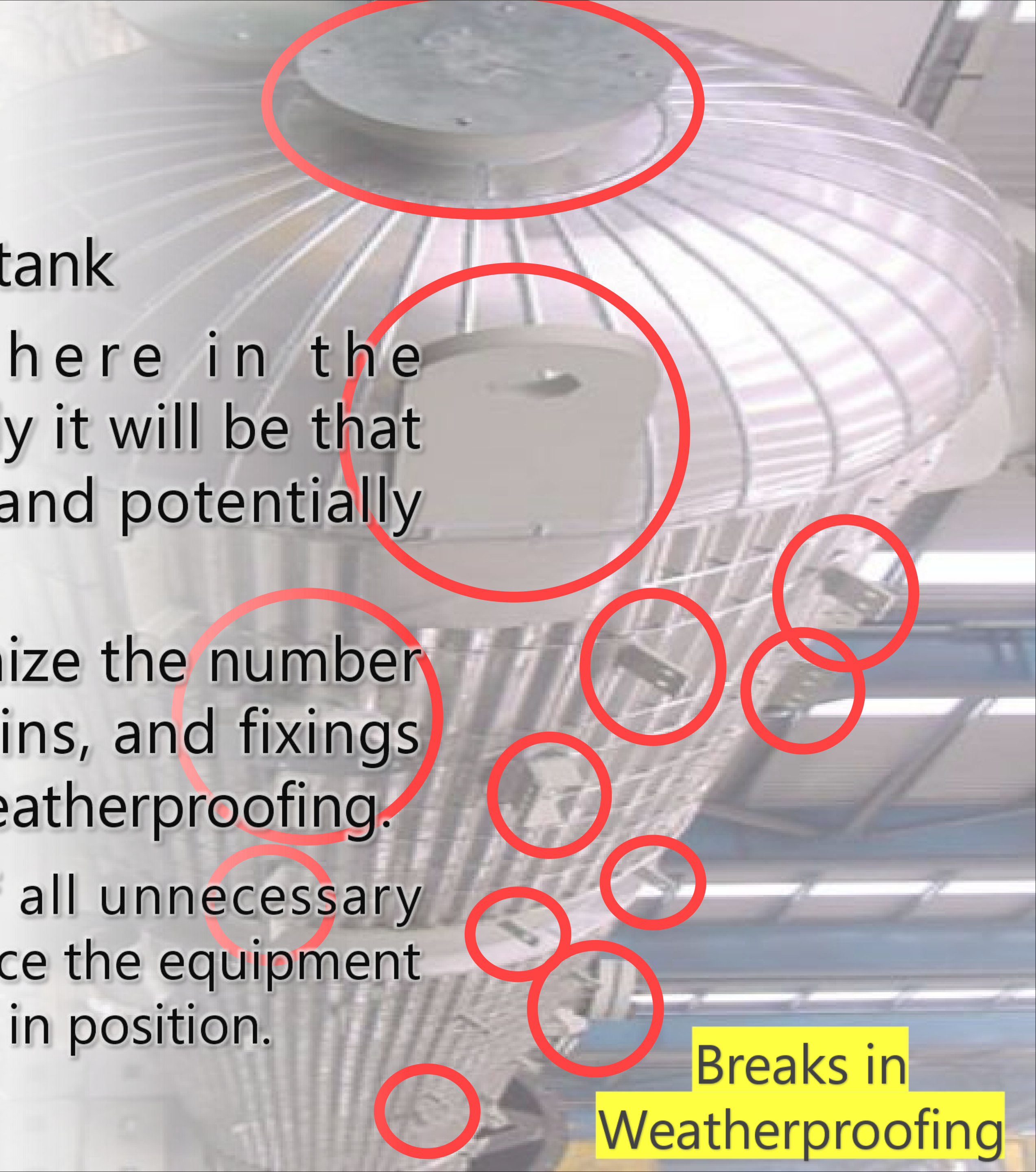
- Design – piping, equipment, and tank
  - Other undesirable design features of an equipment or tank that can influence the rate of CUI are:
    - Using shapes that funnel water into the insulation, such as angle-iron brackets.
    - Items that cause interruption in the weatherproofing, such as lifting lugs, ladder brackets, nozzle extensions, decking and platform supports, nameplates etc.
    - Using shapes that are likely to retain water, such as flat horizontal surfaces, vacuum rings and insulation support rings etc.



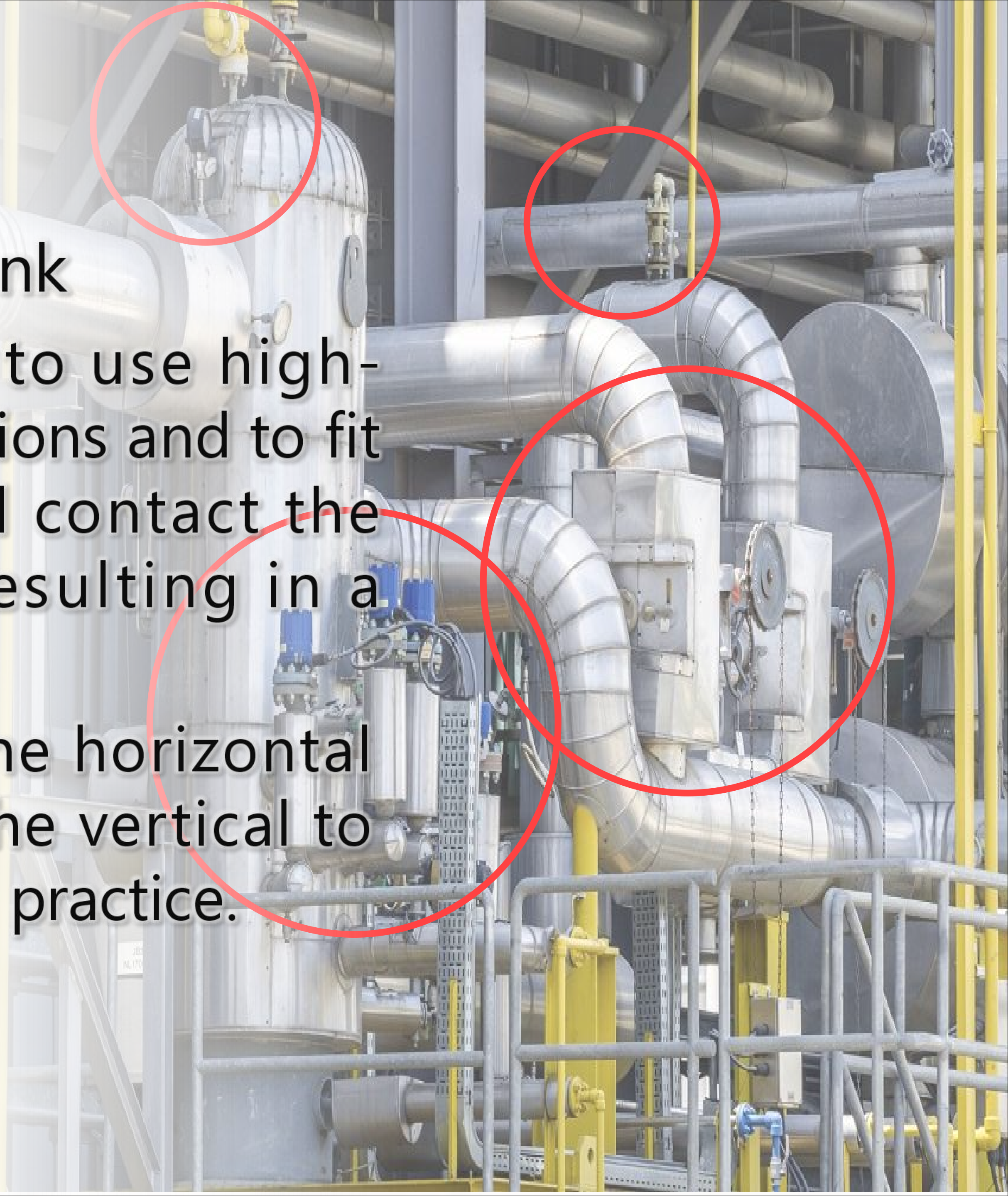
Water Entry Points Through Protrusions

How to Prevent CUI

- Design – piping, equipment, and tank
  - The more breaks that there in the weatherproofing, the more likely it will be that water will enter the insulation and potentially cause CUI.
  - It is therefore essential to minimize the number of nozzles, supports, vents, drains, and fixings that will protrude through the weatherproofing.
    - The good practice is to cut off all unnecessary protrusion such as lifting lugs once the equipment has been lifted and securely fixed in position.


Breaks in Weatherproofing

How to Prevent CUI



- Design – piping, equipment, and tank
  - It is considered good practice to use high-density insulation at support locations and to fit load-bearing supports that will contact the weather proofing only, thus resulting in a continuous weatherproofing.
  - Locating valves and flanges in the horizontal part of piping runs rather than the vertical to limit water retention is also a good practice.

How to Prevent CUI

- Design – piping, equipment, and tank
  - If the risk of CUI is considered very high, for, say, carbon steel, the designer may select another material of construction that will not suffer from CUI.
    - Small diameter piping (3 NPS or less) appears to be prone to CUI leaks because of its low wall thickness, increased number of field welds, coating inefficiency and the tendency to pay less attention during handling, maintenance and inspection.
    - Austenitic or duplex stainless steels, may be selected, accepting that there may still be a risk of CI-ESCC.

Duplex Stainless Steel
The Best Choice for Corrosive Environment

How to Prevent CUI

❑ Design – insulation system

- The next step in the design is proper insulation selection.
- Generally industrial insulation fall into two categories:
  - Low temperature (below ambient)
  - High temperature (above ambient)
- Low temperature insulation typically includes PUF, PIR, flexible elastomeric foam, cellular glass and phenolics etc.
- High temperature insulation typically includes mineral wool, calcium silicate, perlite, cellular glass and fiberglass etc.

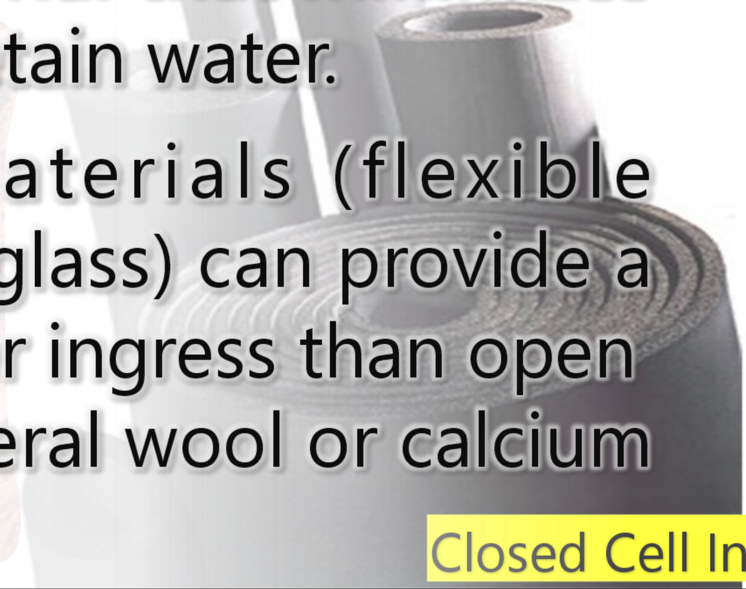
Open Cell Insulation

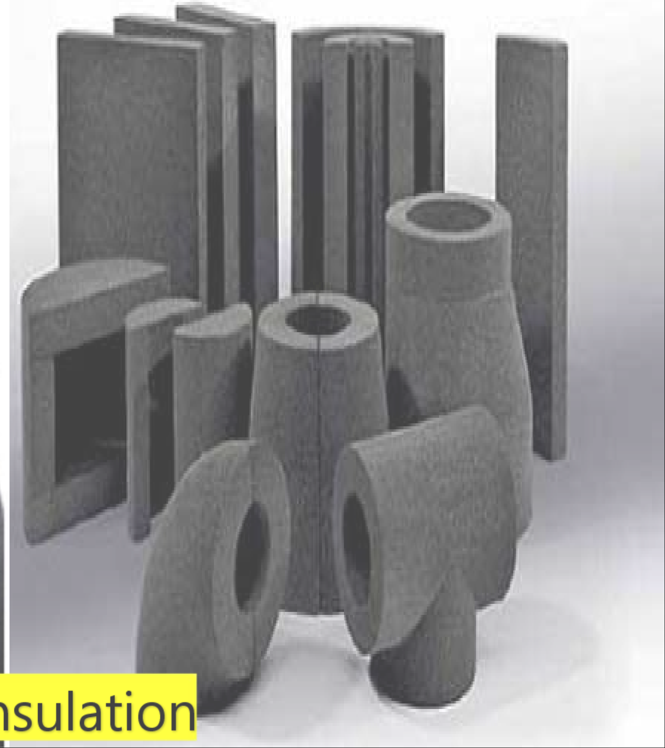
Closed Cell Insulation

How to Prevent CUI

- Design – insulation system
  - Each and every insulation material listed in the previous slide has limitation, advantages and disadvantages.
  - Consideration should be given by the designer to select an insulation material that minimizes water ingress and does not retain water.
  - Closed cell insulation materials (flexible elastomeric foam or cellular glass) can provide a more effective barrier to water ingress than open cell insulation materials (mineral wool or calcium silicate).

Open Cell Insulation

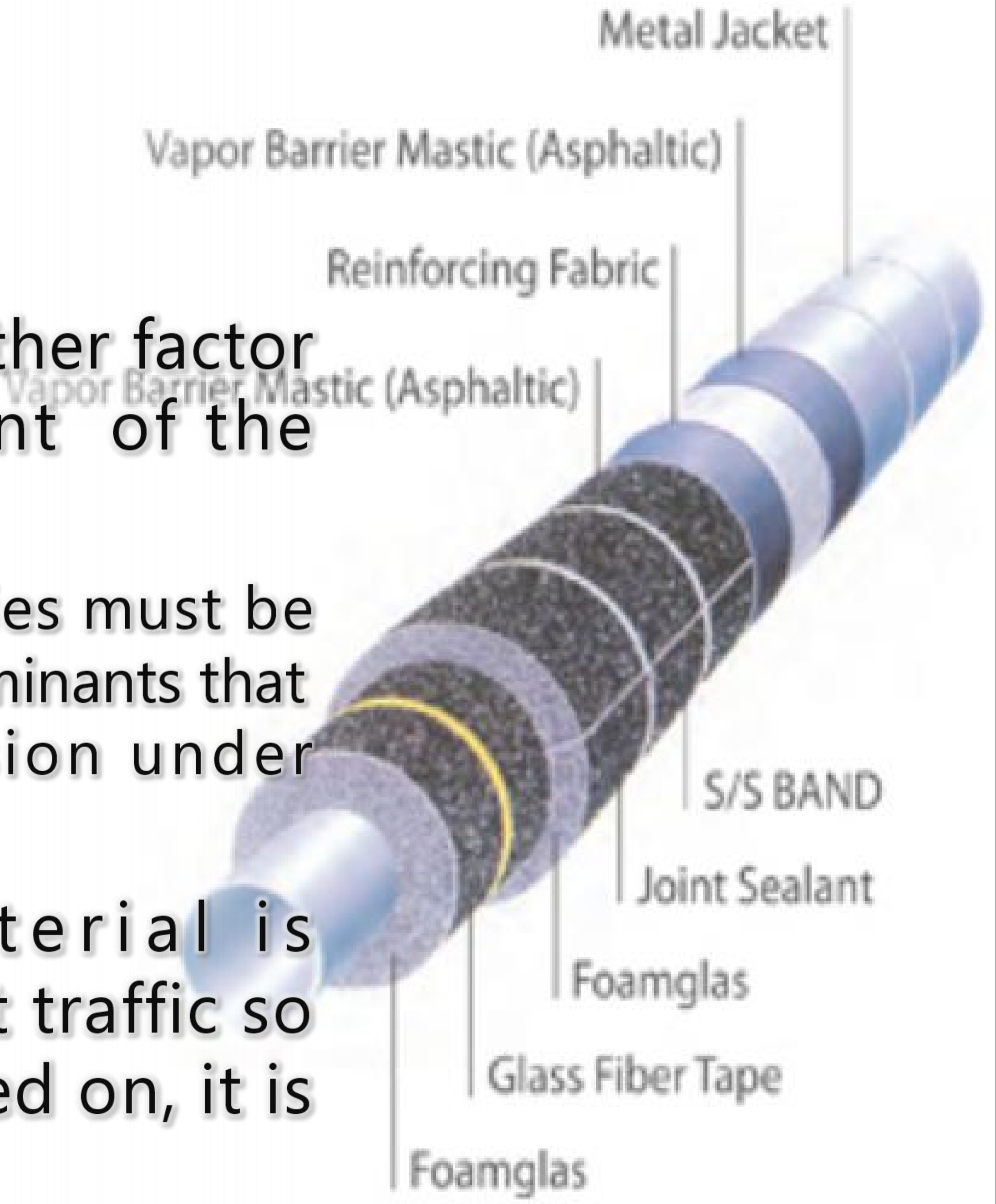




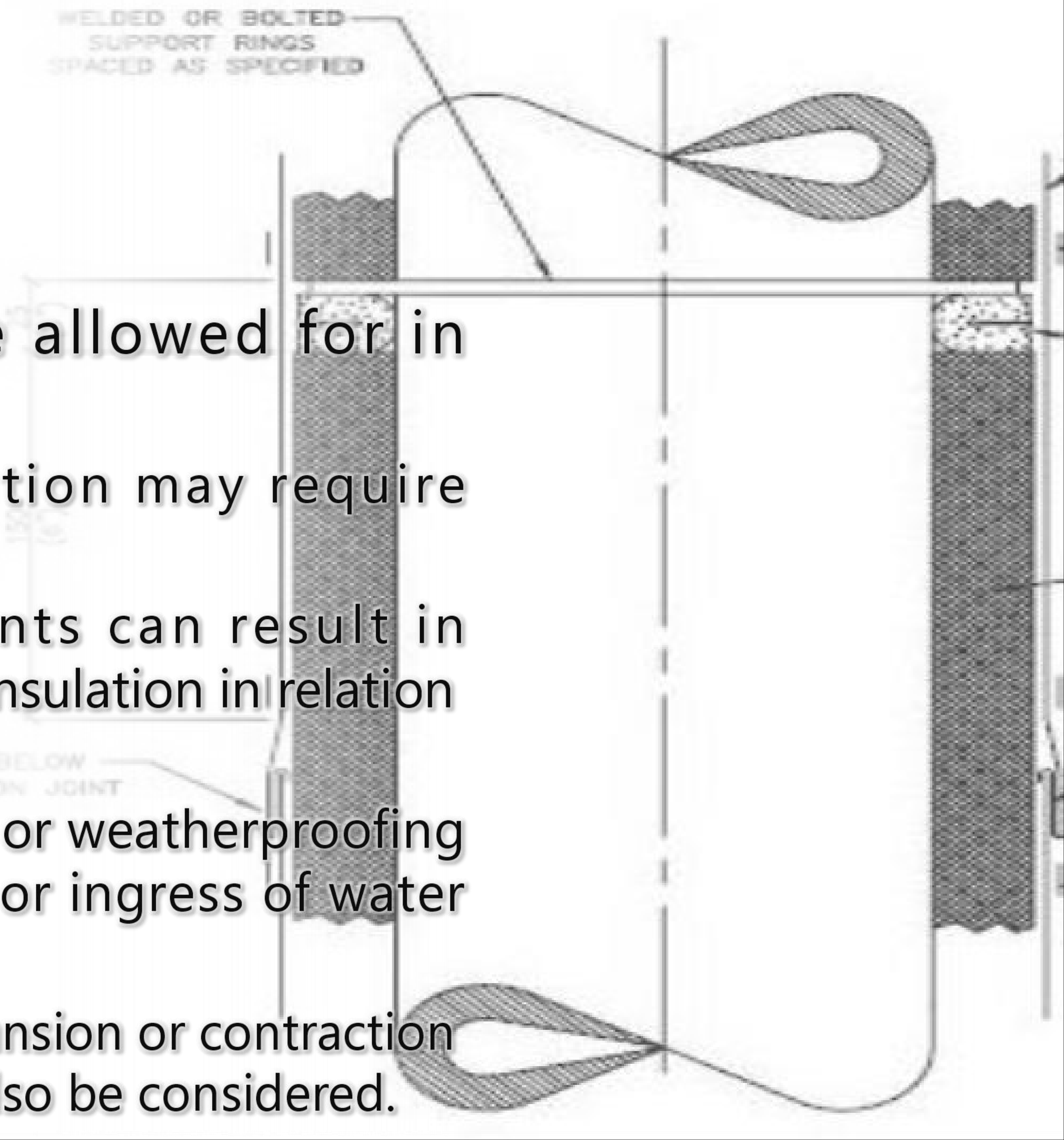
Closed Cell Insulation

How to Prevent CUI

- ☐ Design – insulation system
  - In addition to water absorbency, another factor to consider is the chemical content of the insulation.
    - Insulation materials and its accessories must be free from chloride, salts or other contaminants that can accelerate the rate of corrosion under insulation.
  - High density insulation material is recommended at area's of high foot traffic so that, if the weatherproofing is walked on, it is not easily damage.



How to Prevent CUI

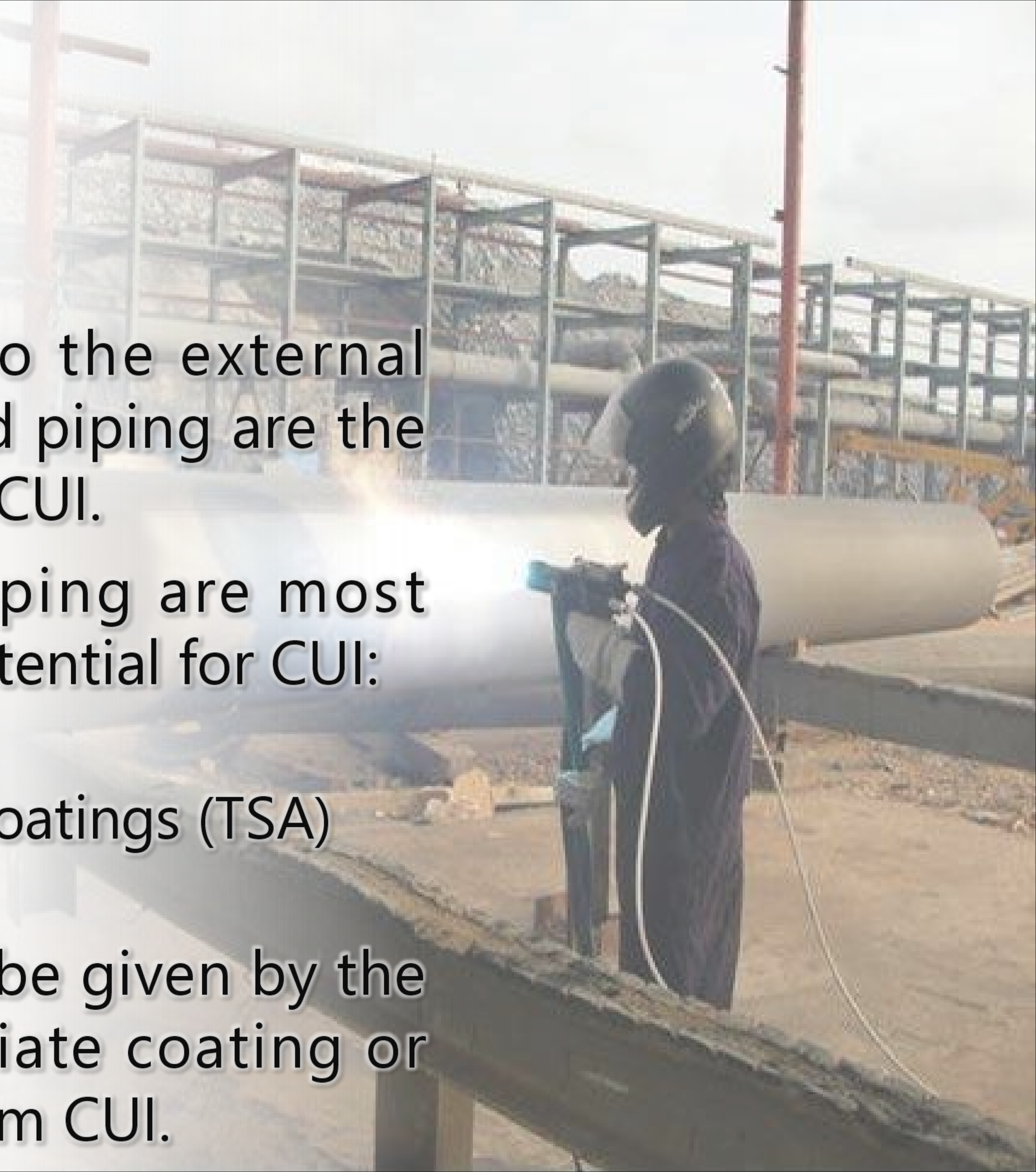


- ❑ Design – insulation system
  - o System movement must be allowed for in insulation system design.
    - Rigid and semi rigid insulation may require expansion joints.
    - Failure to install these joints can result in uncontrolled movement of the insulation in relation to the equipment or piping.
    - This may result in vapor barrier or weatherproofing breakdown and condensation or ingress of water into the insulation.
  - o The linear coefficient of thermal expansion or contraction of both piping and insulation must also be considered.

How to Prevent CUI

- ❑ Design – insulation system
  - Weatherproofing provides mechanical and weather protection for insulation systems.
  - Although weatherproofing acts as a primary barrier to CUI, it susceptible to weather, chemical attack and foot traffic damage once it is installed; therefore consideration should be given to select an appropriate weatherproofing material that can resist the above problems.
  - Insulation weatherproofing materials are basically metallic and non-metallic.
    - ✓ The use of UV-cured GRP weatherproofing provides a more robust barrier that can support foot traffic without becoming damaged.

How to Prevent CUI

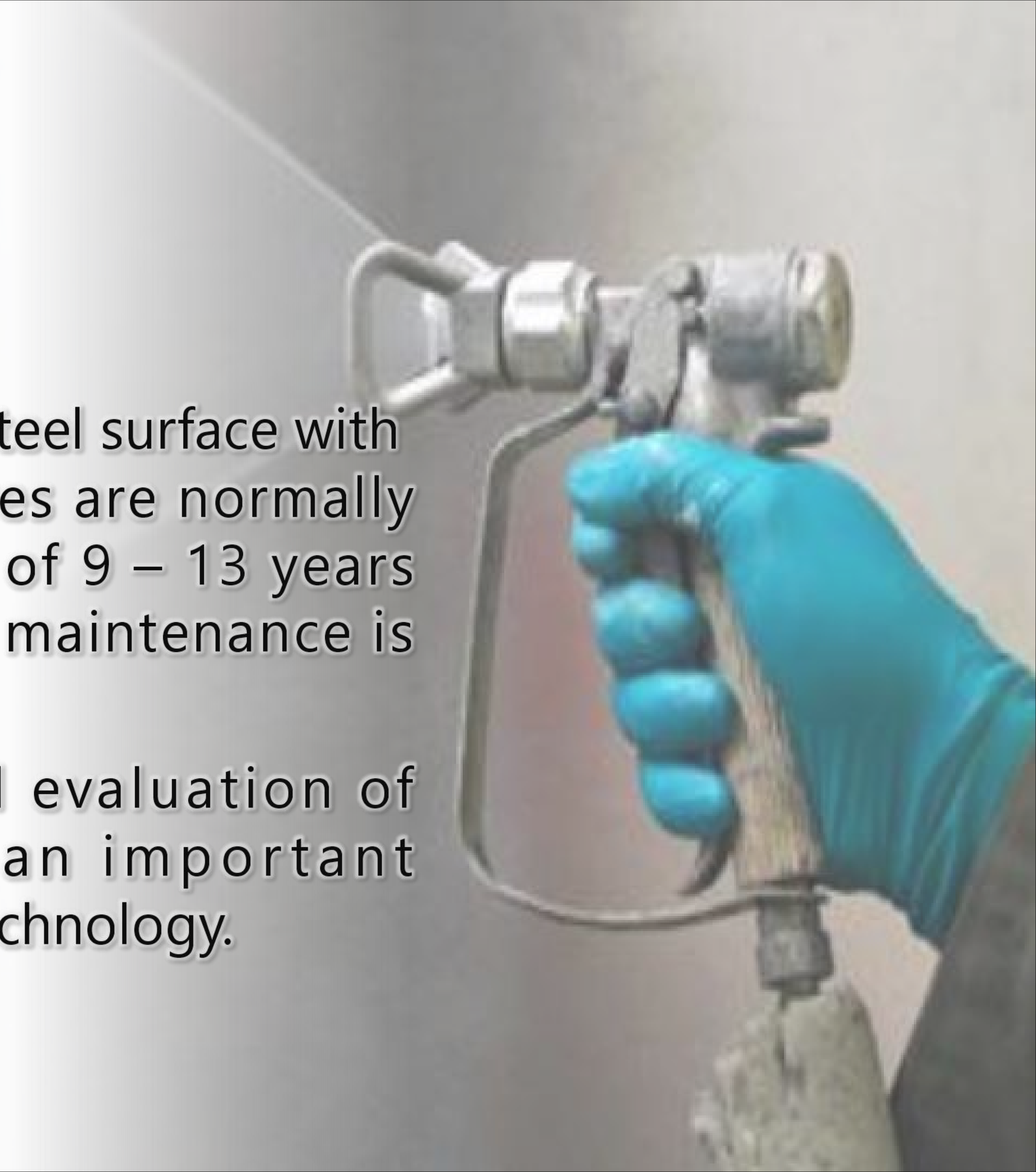


- Protective coating selection
  - Protective coatings applied to the external surface of equipment, tanks, and piping are the last line of defense in preventing CUI.
  - Following coatings and wrapping are most commonly used to reduce the potential for CUI:
    - Organic coatings
    - Thermally sprayed aluminum coatings (TSA)
    - Aluminum wrapping
  - A careful consideration should be given by the designer to select an appropriate coating or wrapping to protect the steel from CUI.

How to Prevent CUI

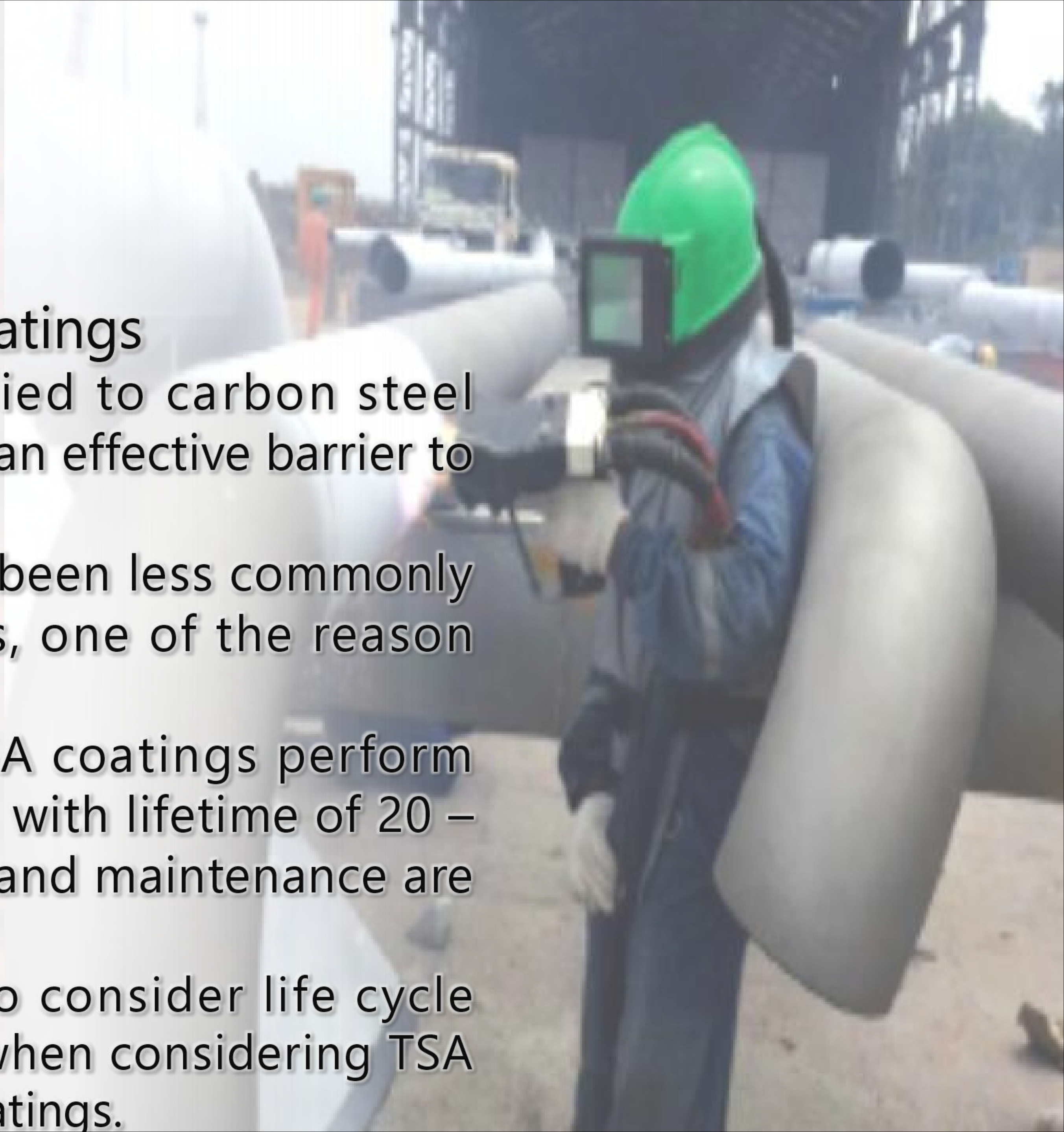
- ❑ Protective coating selection
  - Organic coatings
    - Organic coatings need to be of high-quality immersion grade to provide a barrier to CUI.
    - Organic coatings provides good protection against corrosion, but water ingress into the insulation causes premature coating breakdown and significant CUI.
    - A “brittle” nature of the thin film organic coatings lead to “nicks and scratches” during pipe handling and installation.
    - Permeable nature of the organic coatings continues to be the weak points in CUI.

How to Prevent CUI



- Protective coating selection
  - Organic coatings
    - Coatings applied on a prepared steel surface with good quality control procedures are normally considered to have a lifetime of 9 – 13 years before routine inspection and maintenance is required.
    - Continued development and evaluation of organic coatings remains an important contribution to CUI prevention technology.

How to Prevent CUI



- Protective coating selection
  - Thermally sprayed aluminum coatings
    - TSA coatings have been applied to carbon steel piping or equipment to provide an effective barrier to CUI.
    - Historically, TSA coatings have been less commonly applied than organic coatings, one of the reason could be its initial cost.
    - Experience has shown that TSA coatings perform remarkably well preventing CUI with lifetime of 20 – 30 years before first inspection and maintenance are required.
      - ✓ Therefore, it is important to consider life cycle costing at the design stage when considering TSA coatings instead of organic coatings.

How to Prevent CUI

- ❑ Protective coating selection
    - o Aluminum foil wrapping
        - ▪ Aluminum foil wrapping has most often been applied to insulated austenitic stainless steel piping and equipment to limit the potential for Cl-ESCC.
        - ▪ There is good experience within industry that aluminum foil wrapping has provided a more effective solution than using organic coating.
            - ✓ Foil can act as both physical barrier and galvanic barrier to prevent Cl-ESCC.
        - ▪ Care must be taken to ensure that the external insulation weatherproofing is correctly applied under the control appropriate quality assurance level.

How to Prevent CUI

- Insulation Specification
  - Insulation specifications are critical requirements for insulation system design and insulation work.
  - Specification controls material and installation requirements.
  - Loosely written specifications with insufficient material descriptions and installation requirements may result in costly repairs during construction or after the plant is operational.
  - A specification needs to be complete and detailed, it must clearly describe materials, application, and finishing requirements.

How to Prevent CUI

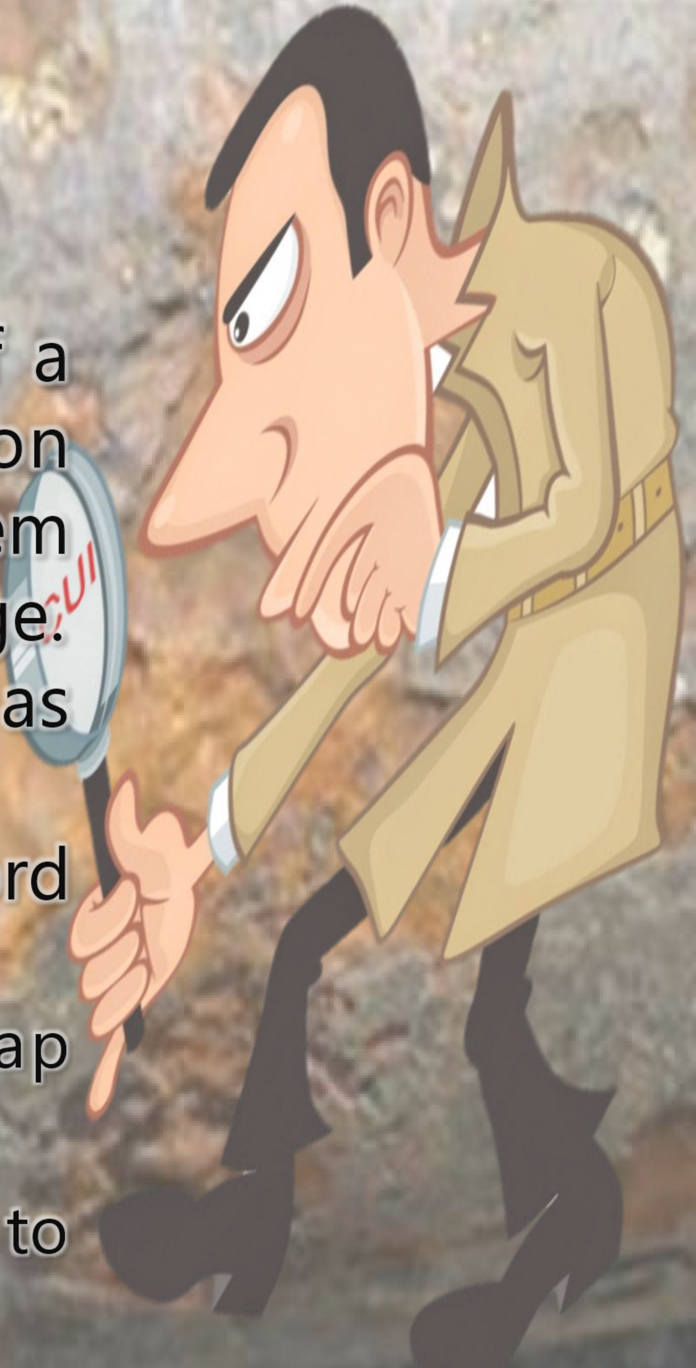
- ❑ Insulation Specification
  - o Common specification flaws to be avoided are:
    - Incorrect application materials
      - ✓ Open cell or wicking type insulation materials, such as calcium silicate and fibrous products, specified for below-ambient temperature applications.
    - Product specification by using a generic name without stating the properties required for the intended service.
    - Improper and unclear application methods
      - ✓ Incorrect multi-layer schedules, lack of expansion joints, missing vapor barriers, and incorrect insulation system securement methods etc.

How to Prevent CUI

- ❑ Craftmanship – Insulation installation/Maint.
  - Another critical factor that is frequently overlooked is to review in detail with the supervision responsible for insulation installation during plant construction stage, maintenance stage and so forth.
  - An skilled and trained workmanship is necessary to install and maintain an insulation system.
    - IOGS certified insulation applicators (CIA) are recommended for installation and maintenance.
  - Inspection following installation must be made frequently on a routine basis by a qualified person.
    - IOGS certified insulation inspectors (CII) are recommended to perform insulation inspection.

How to Prevent CUI

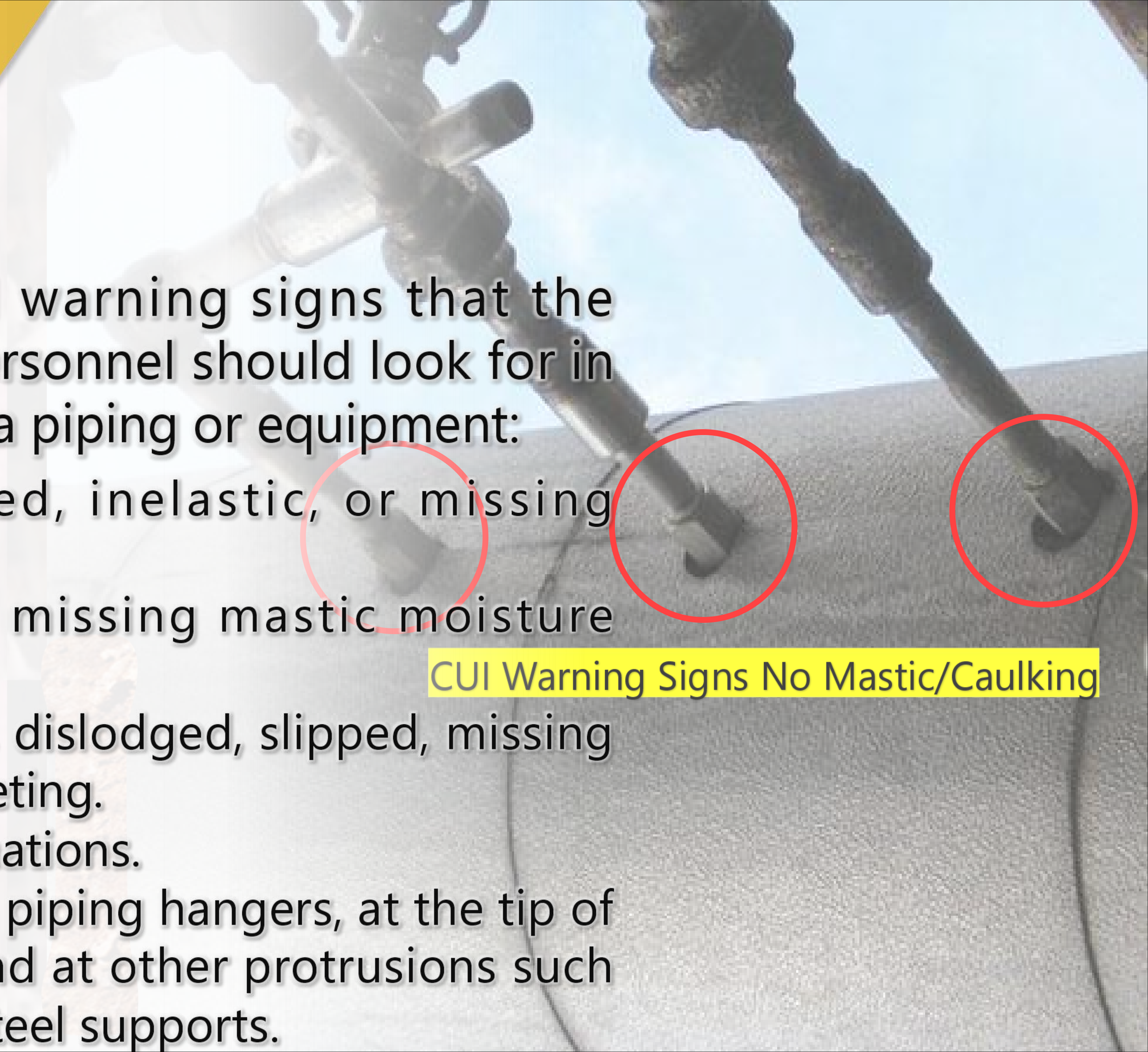
- Ongoing inspection
  - It is considered to be an important duty of a facility owner to assign a dedicated insulation team to inspect and maintain an insulation system during the plant operation and maintenance stage.
  - The ongoing inspection should include visual as well as NDT.
  - A plan should be developed to inspect and record warning signs of CUI.
    - It is helpful to begin with a plant or area map indicating location of equipment.
    - The map should be used as a point of departure to prioritized, inspect, and record suspect insulation.



How to Prevent CUI

☐ Ongoing inspection

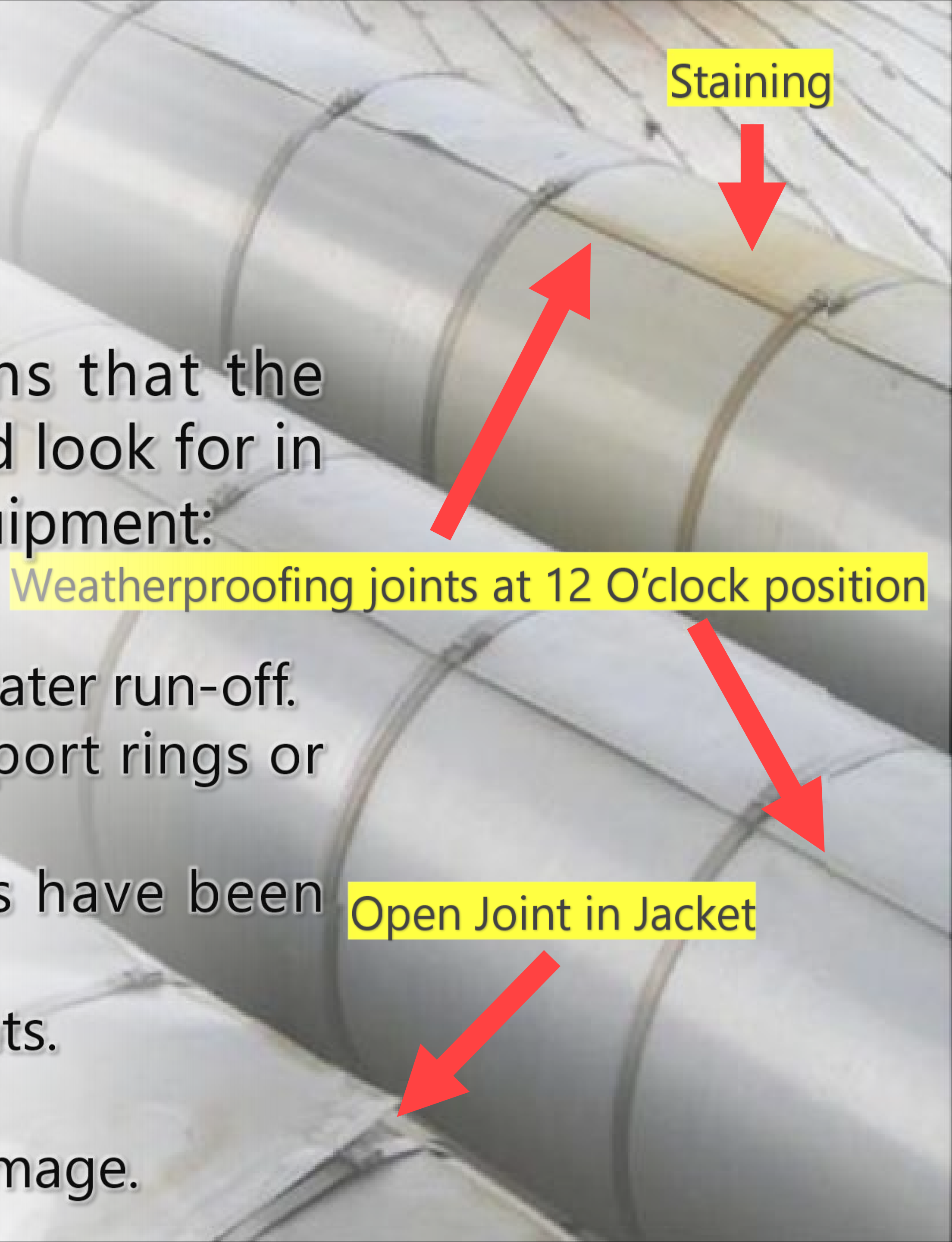
- Following are the CUI warning signs that the insulation inspection personnel should look for in a CUI suspected area of a piping or equipment:
  - Weathered, damaged, inelastic, or missing caulking/sealant.
  - Weathered, split, or missing mastic moisture barriers.
  - Punctured, torn, loose, dislodged, slipped, missing or corroded metal jacketing.
  - Unsealed piping terminations.
  - Gaps in jackets around piping hangers, at the tip of vertical piping runs, and at other protrusions such as structural stainless steel supports.



CUI Warning Signs No Mastic/Caulking

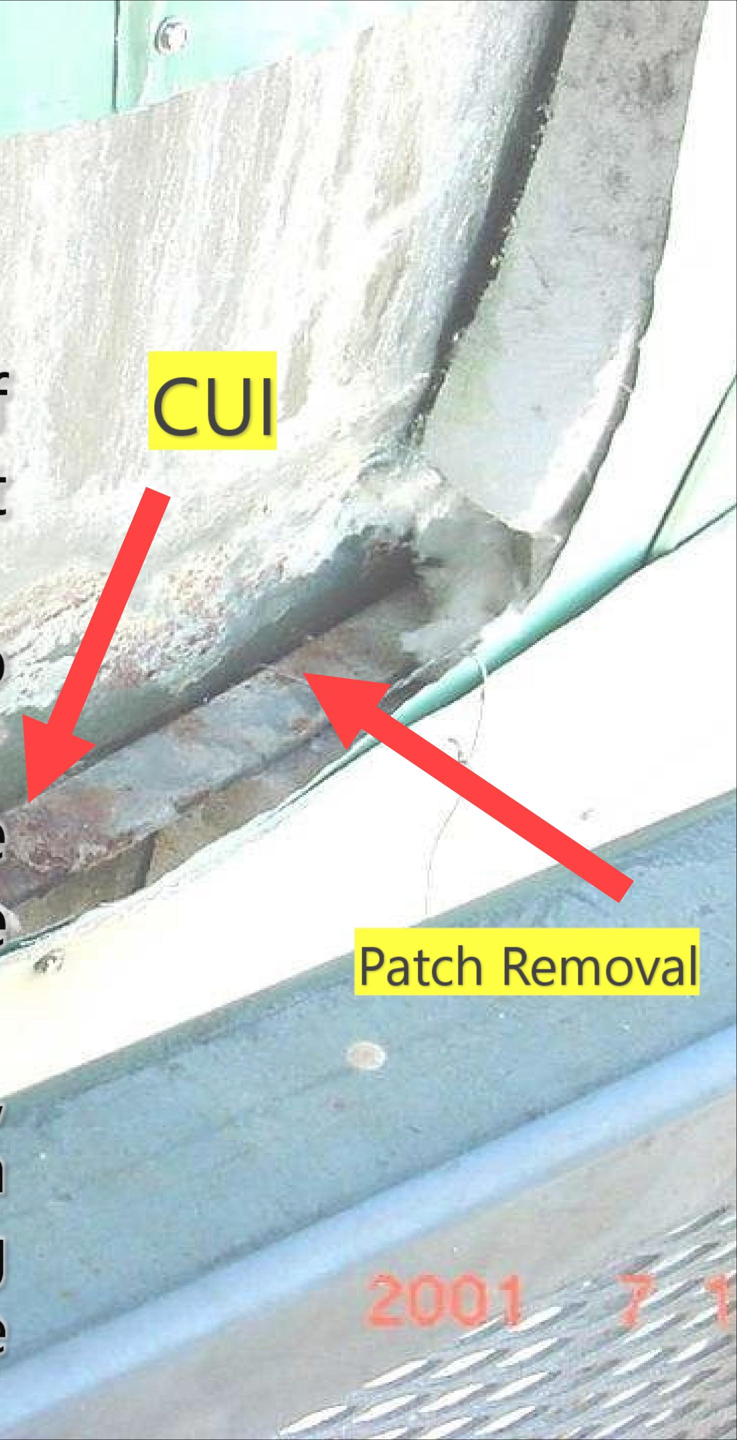
How to Prevent CUI

- Ongoing inspection
  - Following are the CUI warning signs that the insulation inspection personnel should look for in a CUI suspected area of a piping or equipment:
    - Swollen or blistered insulation.
    - Improper installation interfering with water run-off.
    - Mildew or moisture at insulation support rings or vacuum rings.
    - Unprotected insulation where parts have been removed.
    - Unsealed metal wall thickness test points.
    - Flashing that does not shed water.
    - Open joints in jackets from physical damage.



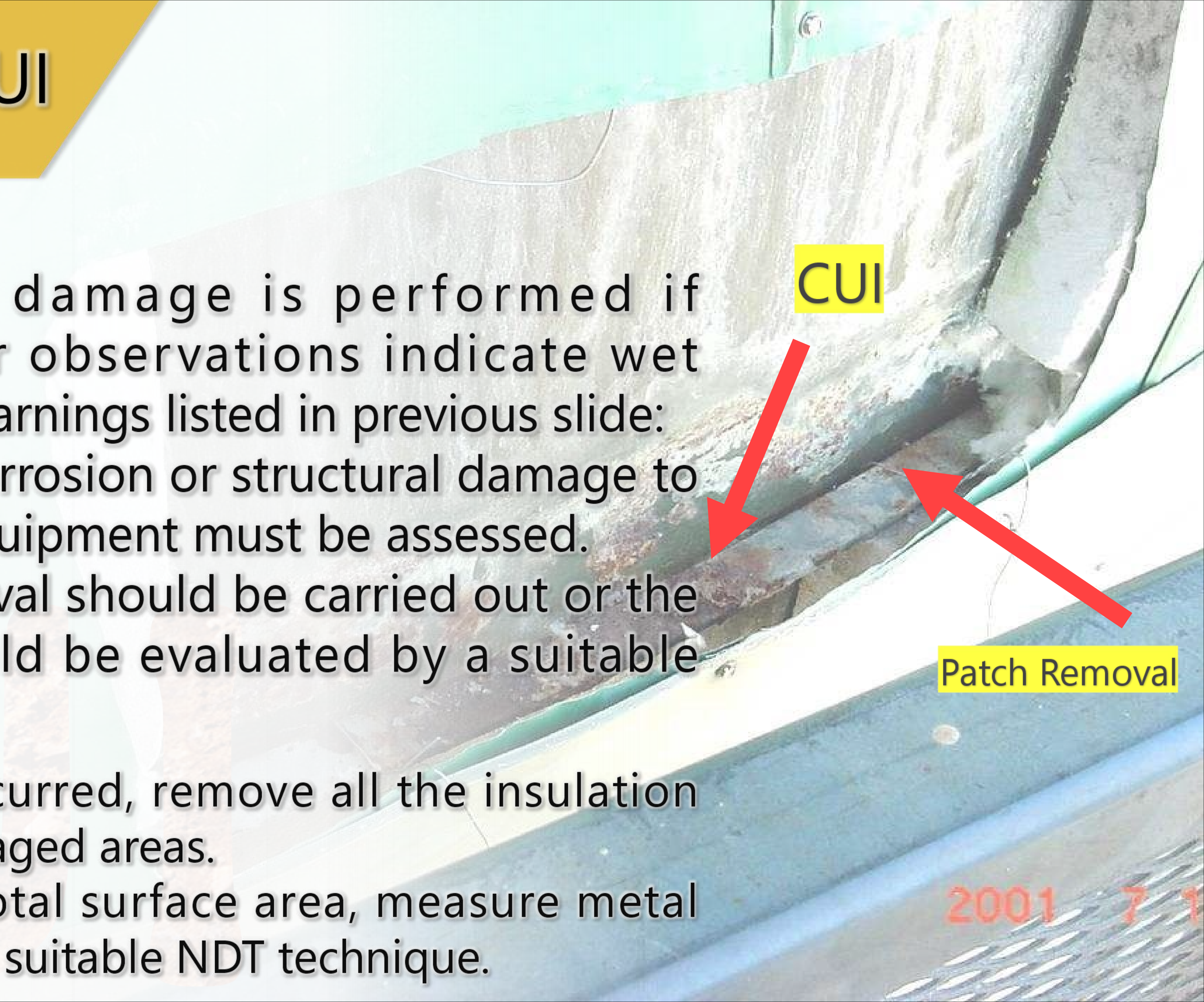
How to Prevent CUI

- ❑ Ongoing inspection
  - o Assessment of damage is performed if investigations or observations indicate wet insulation/CUI warning(s) listed in previous slide:
    - ▪ The extent of corrosion or structural damage to the piping or equipment must be assessed.
    - ▪ Insulation removal should be carried out or the corrosion should be evaluated by a suitable NDT technique.
      - ✓ Remove a patch insulation, 18 – 24 in^2 in area, from vessel or piping >24in in diameter, or a section approximately 3ft long from piping <24in in diameter where there is probable corrosion damage.



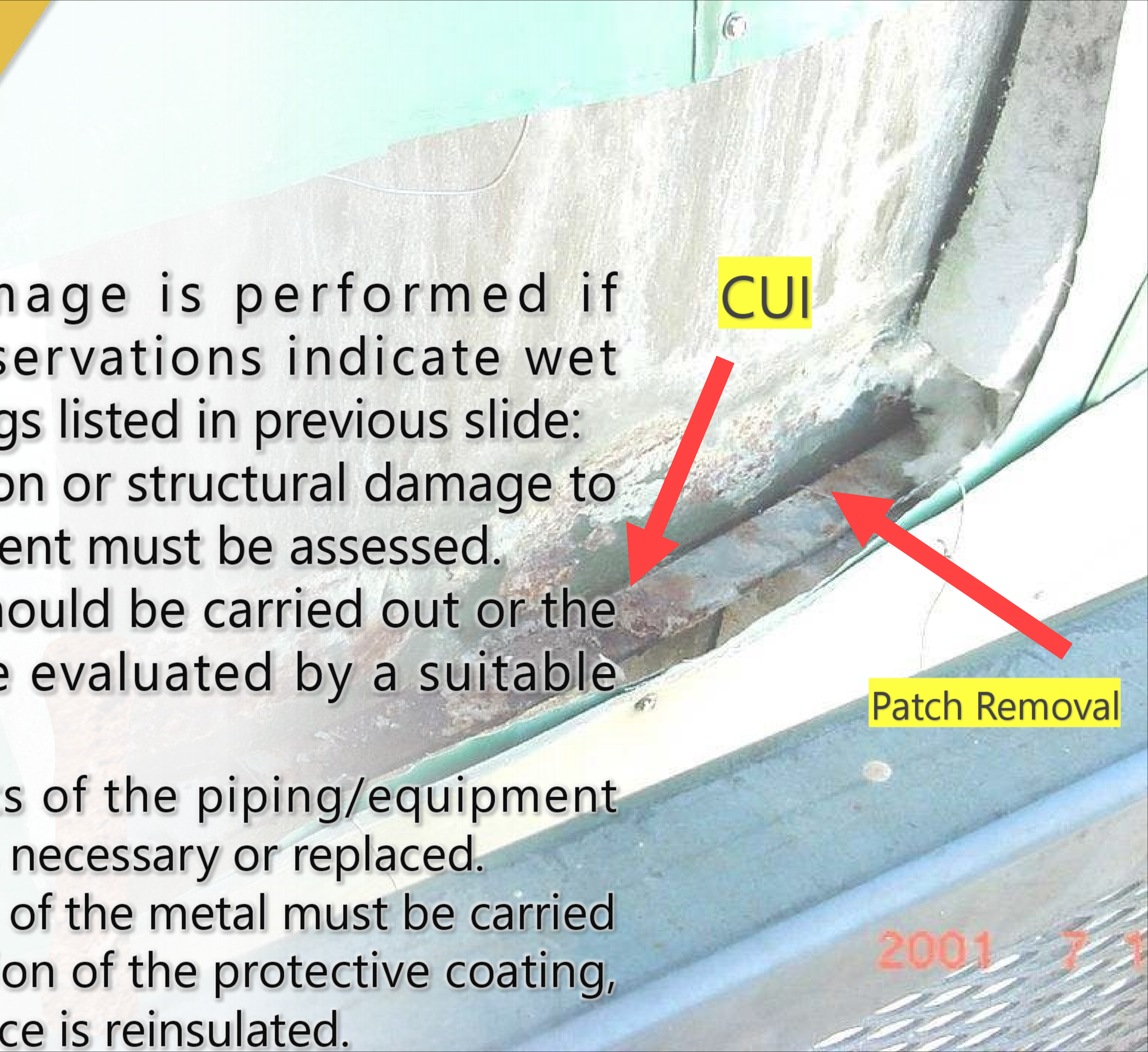
How to Prevent CUI

- Ongoing inspection
  - Assessment of damage is performed if investigations or observations indicate wet insulation or CUI warnings listed in previous slide:
    - The extent of corrosion or structural damage to the piping or equipment must be assessed.
    - Insulation removal should be carried out or the corrosion should be evaluated by a suitable NDT technique.
      - ✓ If CUI has occurred, remove all the insulation from the damaged areas.
      - ✓ Inspect the total surface area, measure metal thickness by a suitable NDT technique.



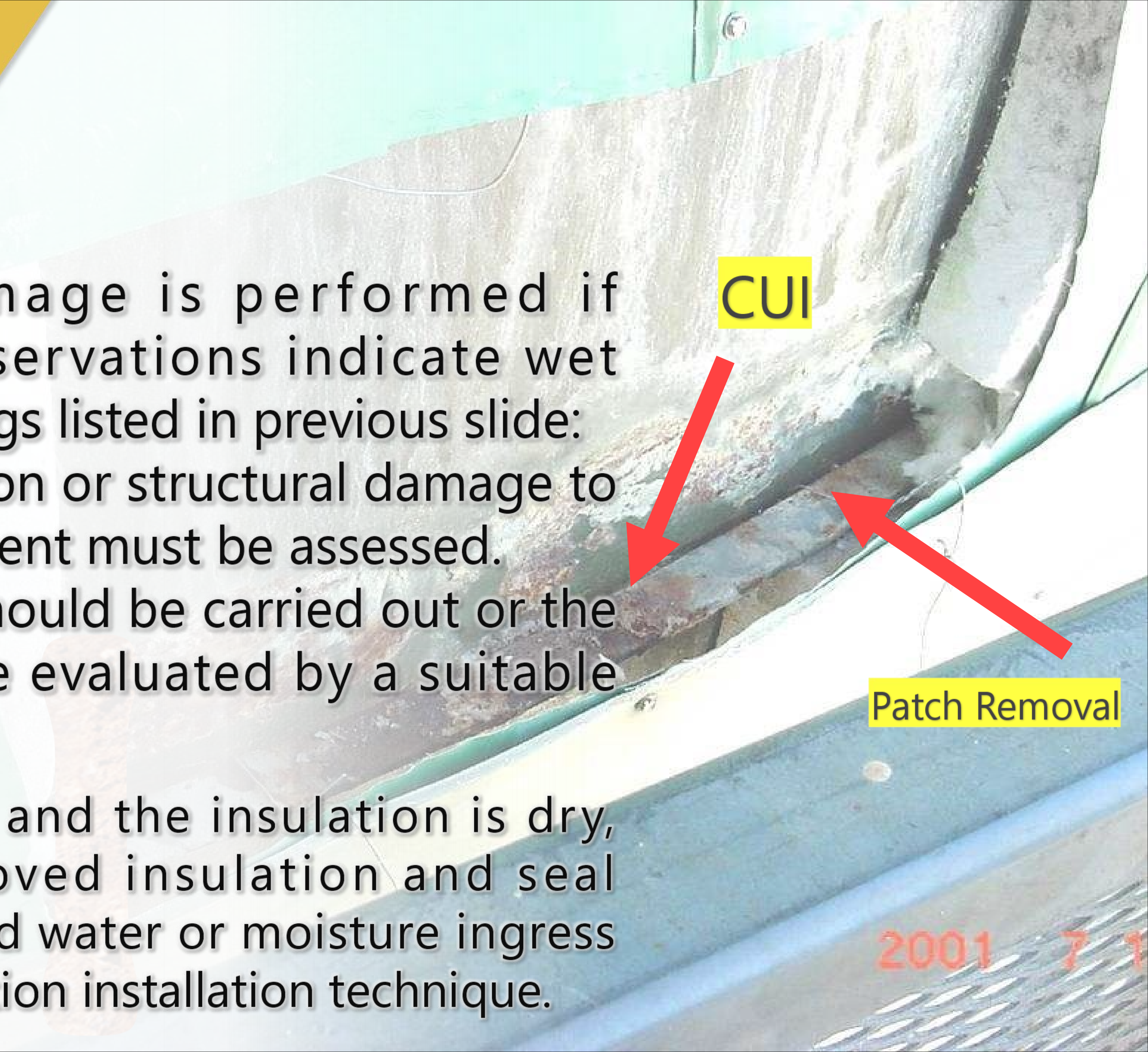
How to Prevent CUI

- ❑ Ongoing inspection
  - Assessment of damage is performed if investigations or observations indicate wet insulation or CUI warnings listed in previous slide:
    - The extent of corrosion or structural damage to the piping or equipment must be assessed.
    - Insulation removal should be carried out or the corrosion should be evaluated by a suitable NDT technique.
      - ✓ The damaged parts of the piping/equipment must be repaired as necessary or replaced.
      - ✓ Surface preparation of the metal must be carried out before application of the protective coating, and finally the surface is reinsulated.



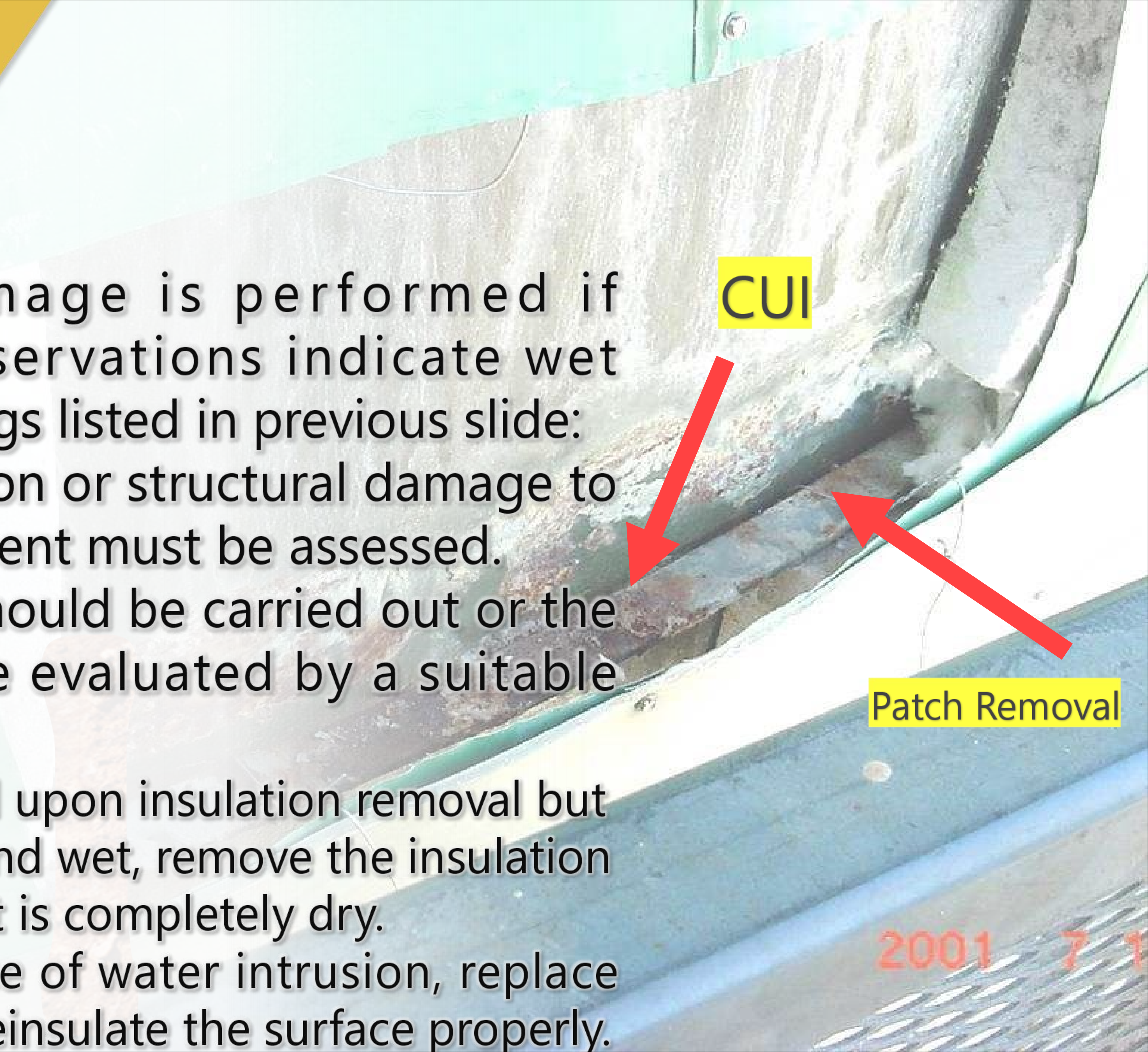
How to Prevent CUI

- ❑ Ongoing inspection
  - Assessment of damage is performed if investigations or observations indicate wet insulation or CUI warnings listed in previous slide:
    - The extent of corrosion or structural damage to the piping or equipment must be assessed.
    - Insulation removal should be carried out or the corrosion should be evaluated by a suitable NDT technique.
      - ✓ If there is no CUI and the insulation is dry, replace the removed insulation and seal thoroughly to avoid water or moisture ingress using proper insulation installation technique.

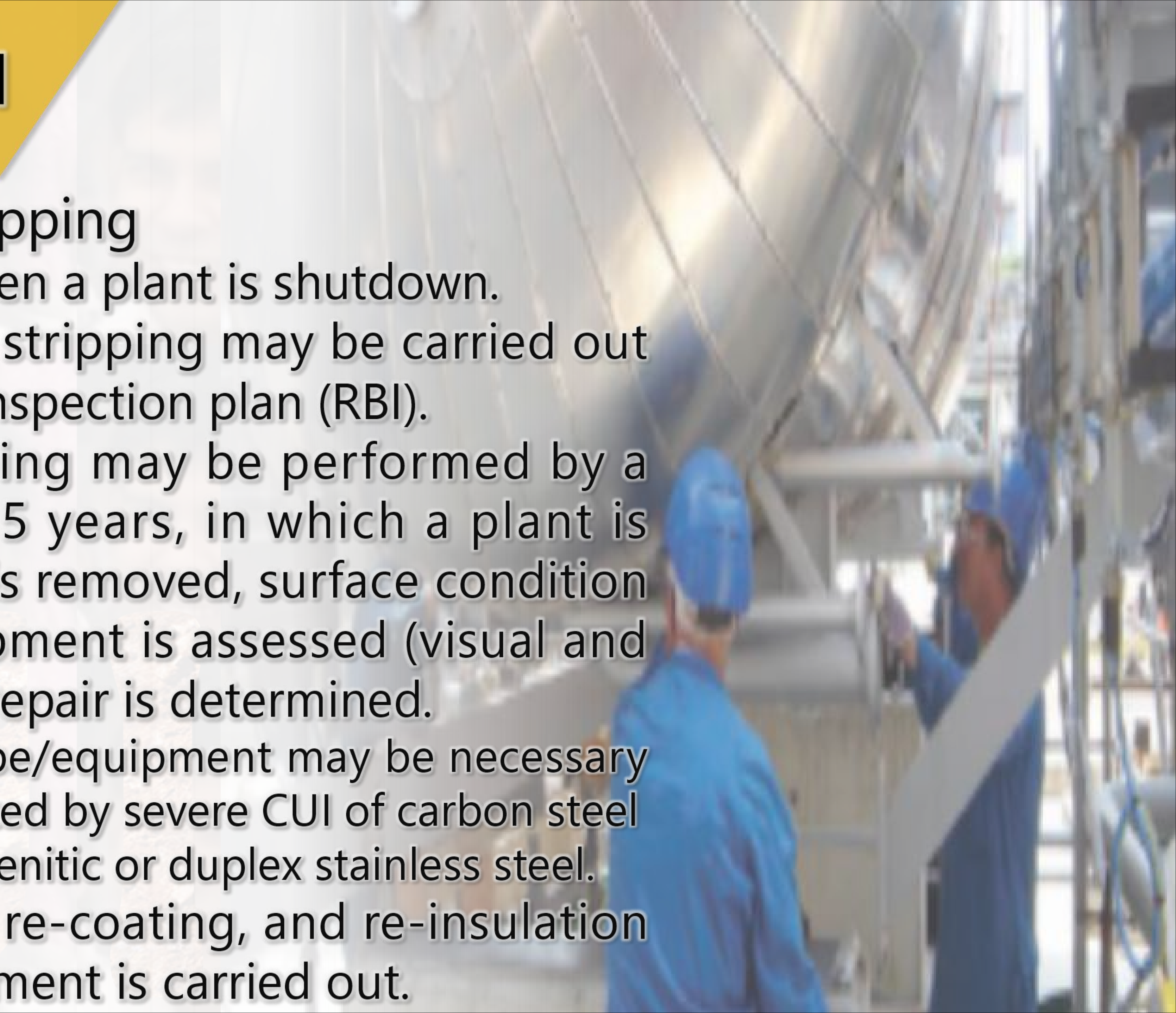


How to Prevent CUI

- Ongoing inspection
  - Assessment of damage is performed if investigations or observations indicate wet insulation or CUI warnings listed in previous slide:
    - The extent of corrosion or structural damage to the piping or equipment must be assessed.
    - Insulation removal should be carried out or the corrosion should be evaluated by a suitable NDT technique.
      - ✓ If no CUI is detected upon insulation removal but the insulation is found wet, remove the insulation to the point where it is completely dry.
      - ✓ Eliminate the source of water intrusion, replace the insulation and reinsulate the surface properly.

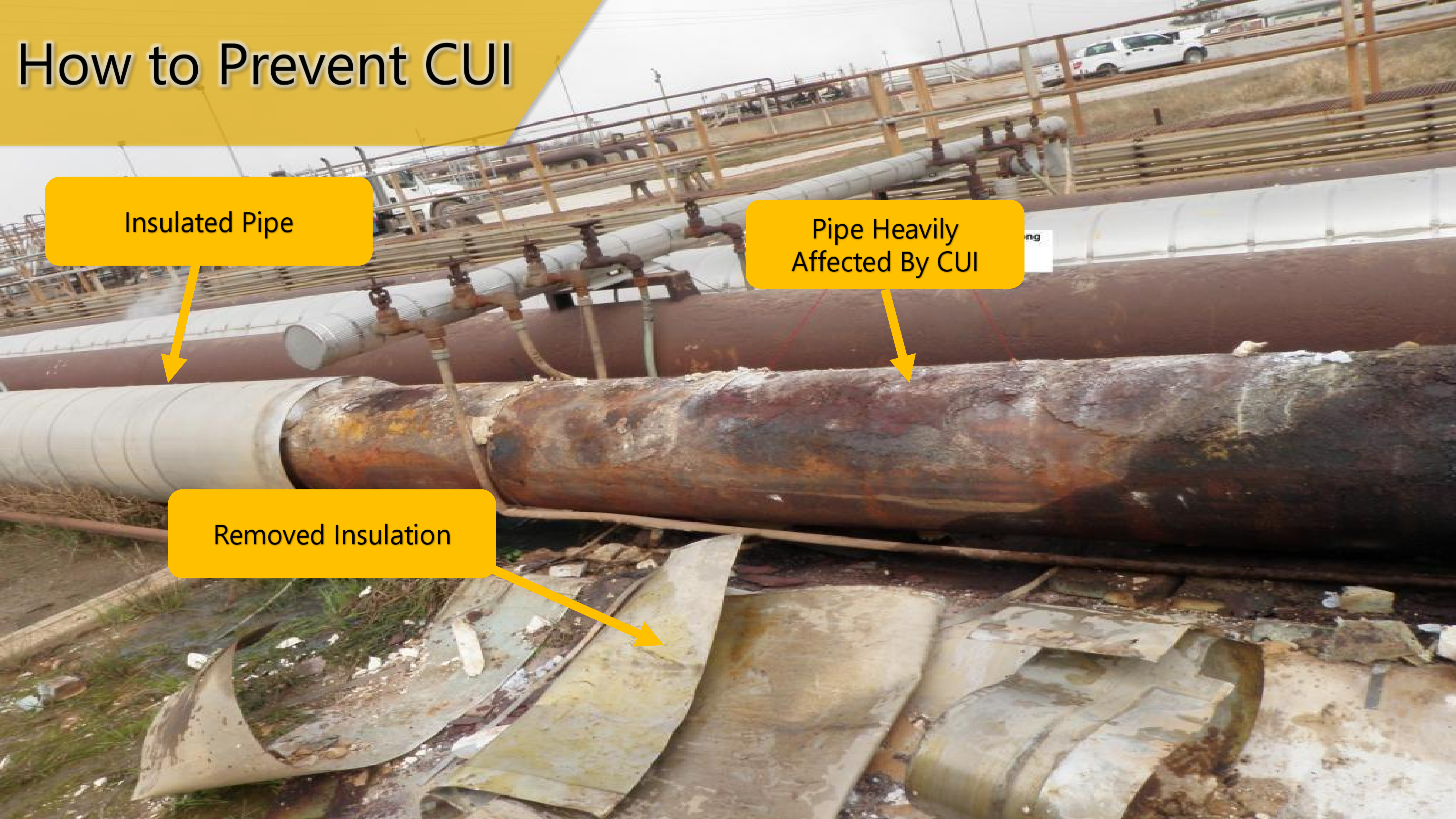


How to Prevent CUI



- Periodic insulation stripping
  - This is mostly seen when a plant is shutdown.
  - Insulation removal or stripping may be carried out based on Risk Based Inspection plan (RBI).
  - The insulation stripping may be performed by a facility owner every 5 years, in which a plant is shutdown, insulation is removed, surface condition of the piping or equipment is assessed (visual and NDT), and method of repair is determined.
    - Replacement of a pipe/equipment may be necessary if its integrity is affected by severe CUI of carbon steel or by Cl-ESCC of austenitic or duplex stainless steel.
  - Finally blast cleaning, re-coating, and re-insulation of the piping or equipment is carried out.

How to Prevent CUI

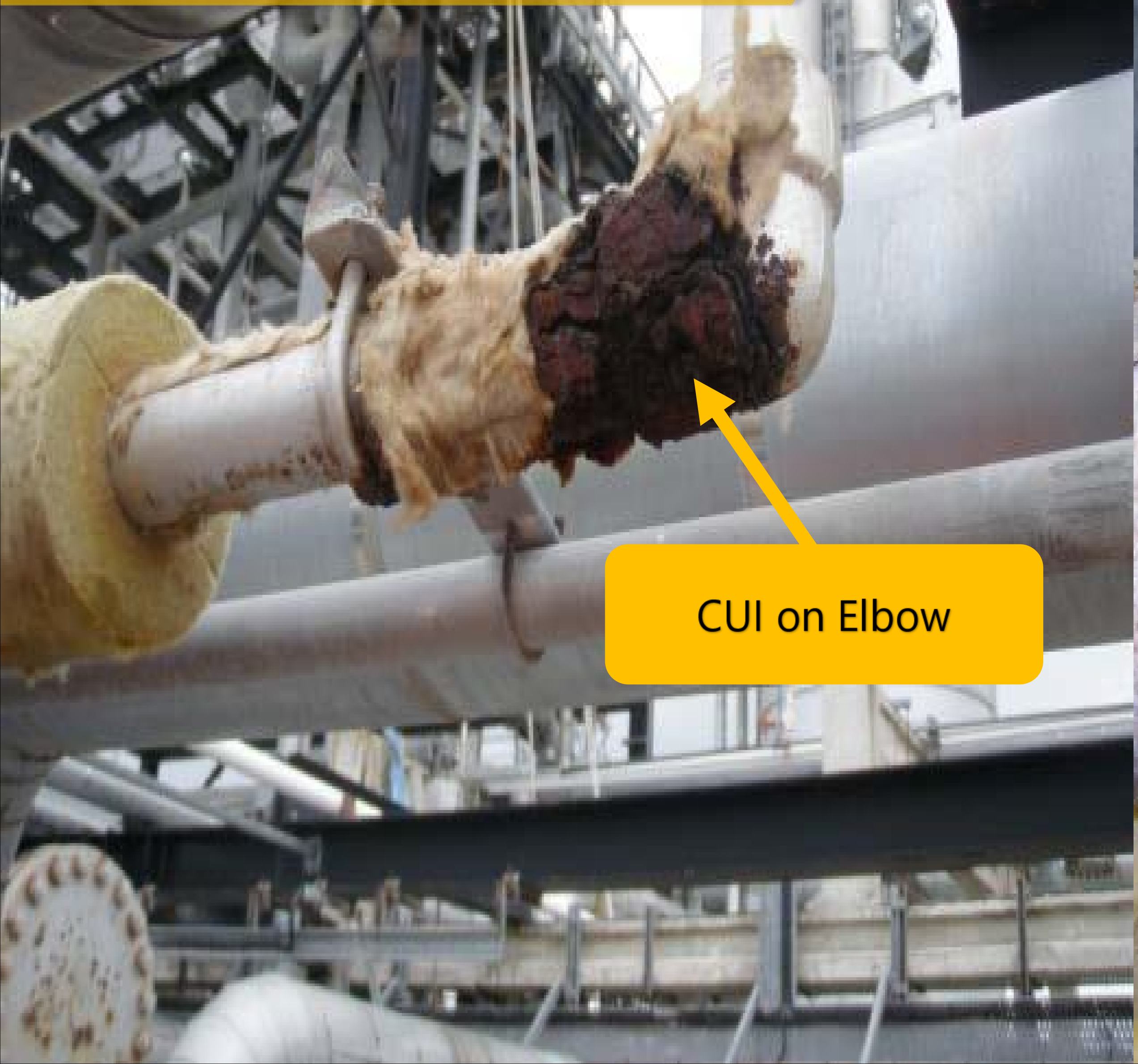


Insulated Pipe

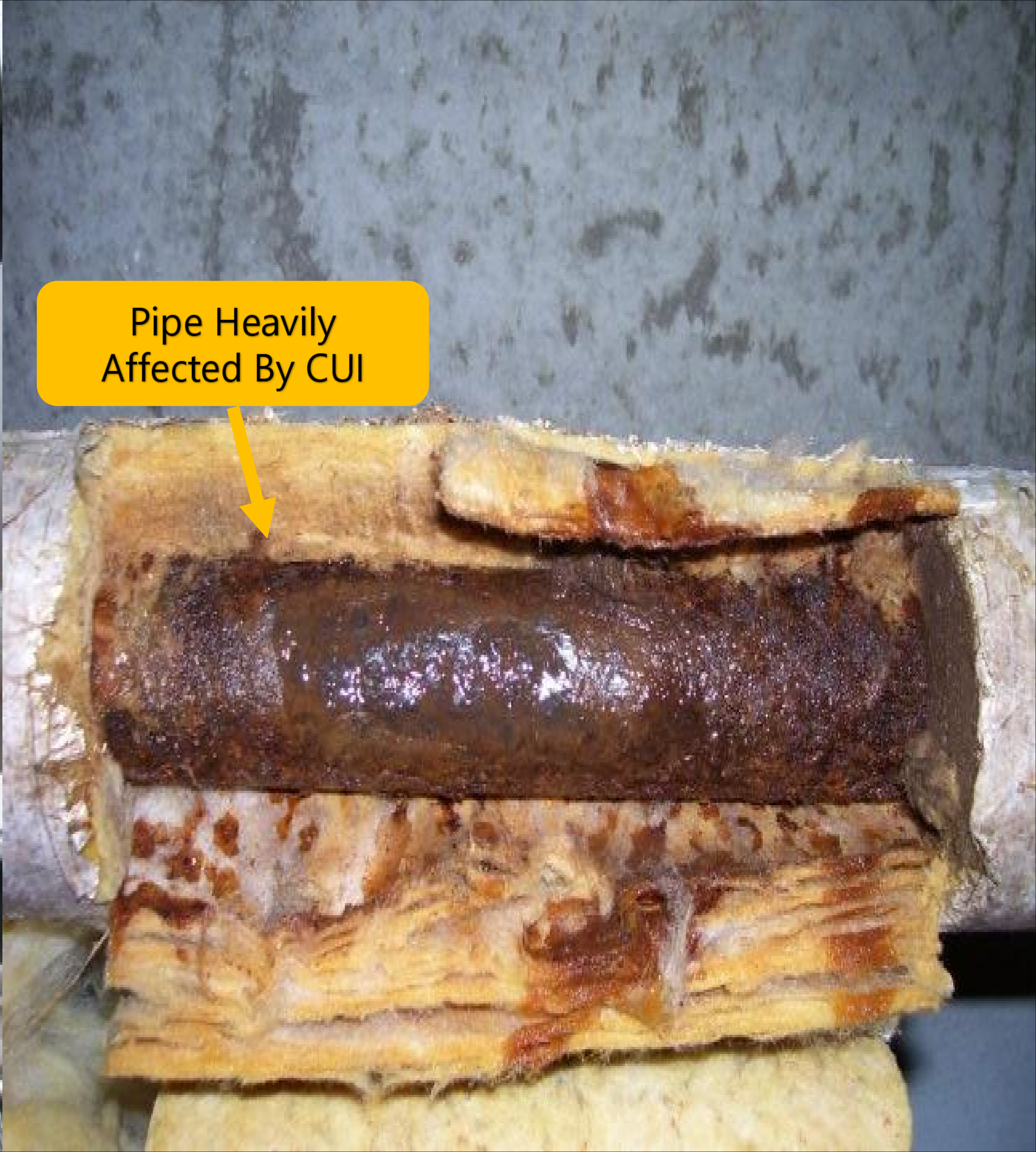
Pipe Heavily Affected By CUI

Removed Insulation

How to Prevent CUI

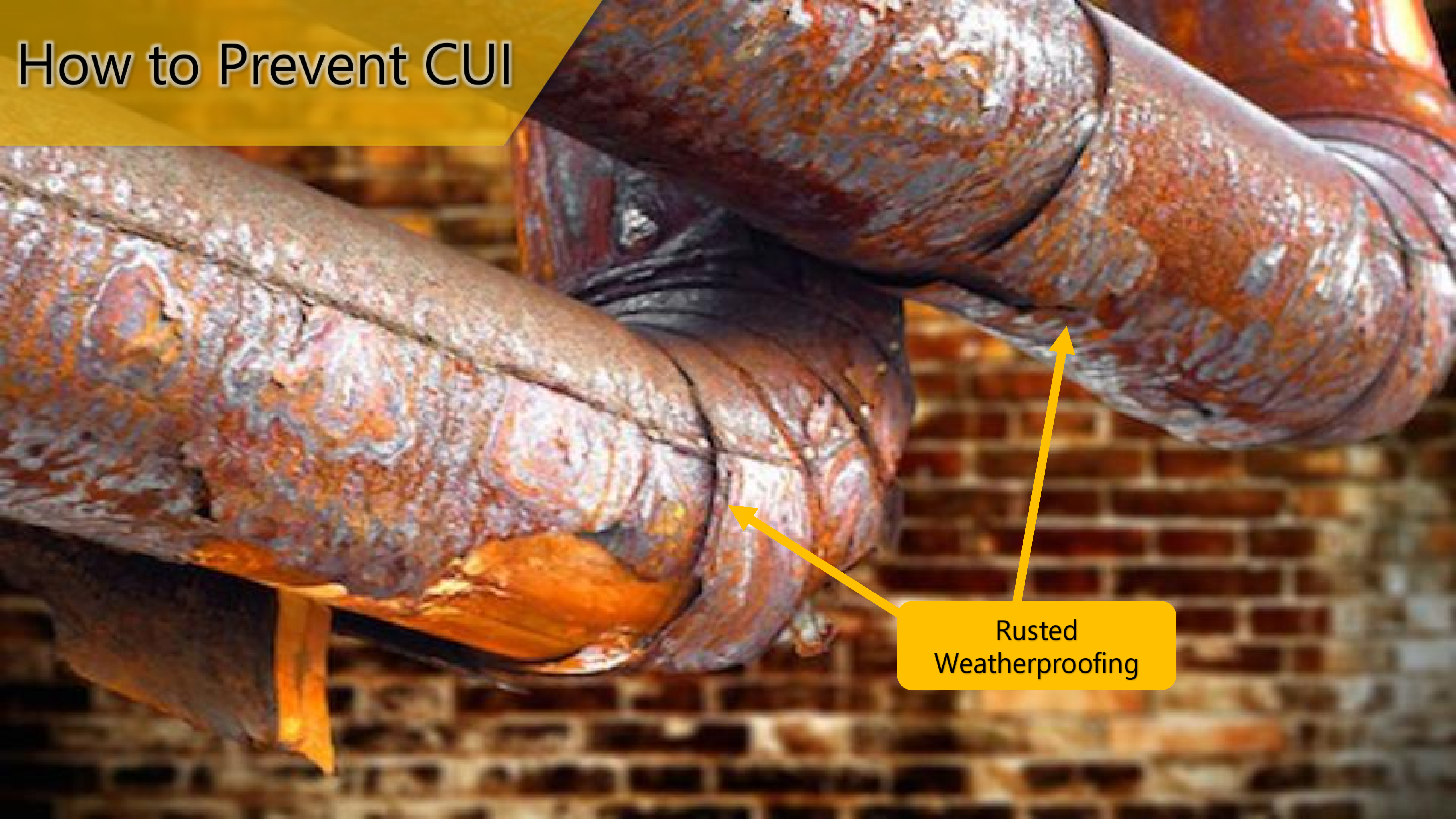


CUI on Elbow



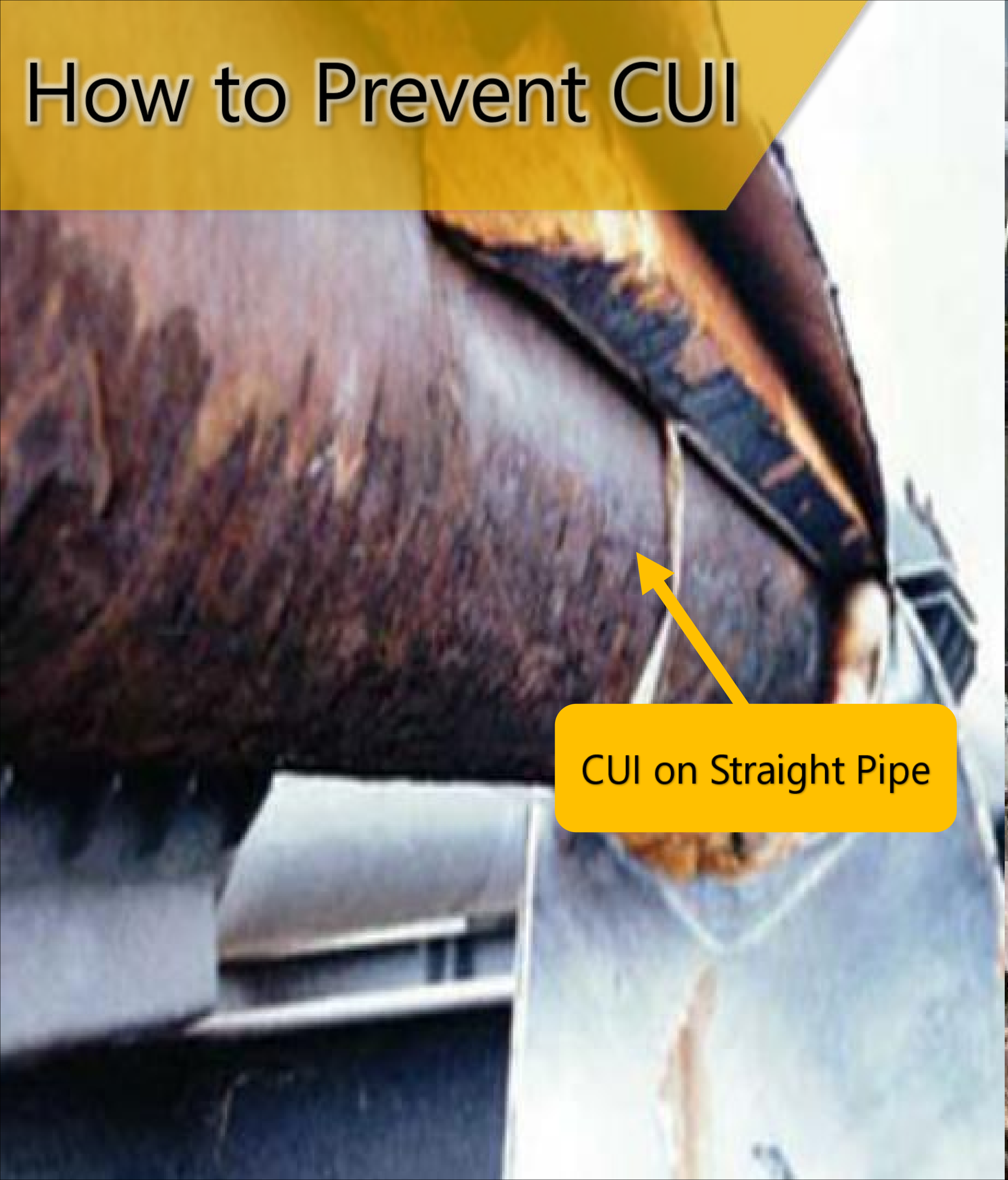
Pipe Heavily Affected By CUI

How to Prevent CUI

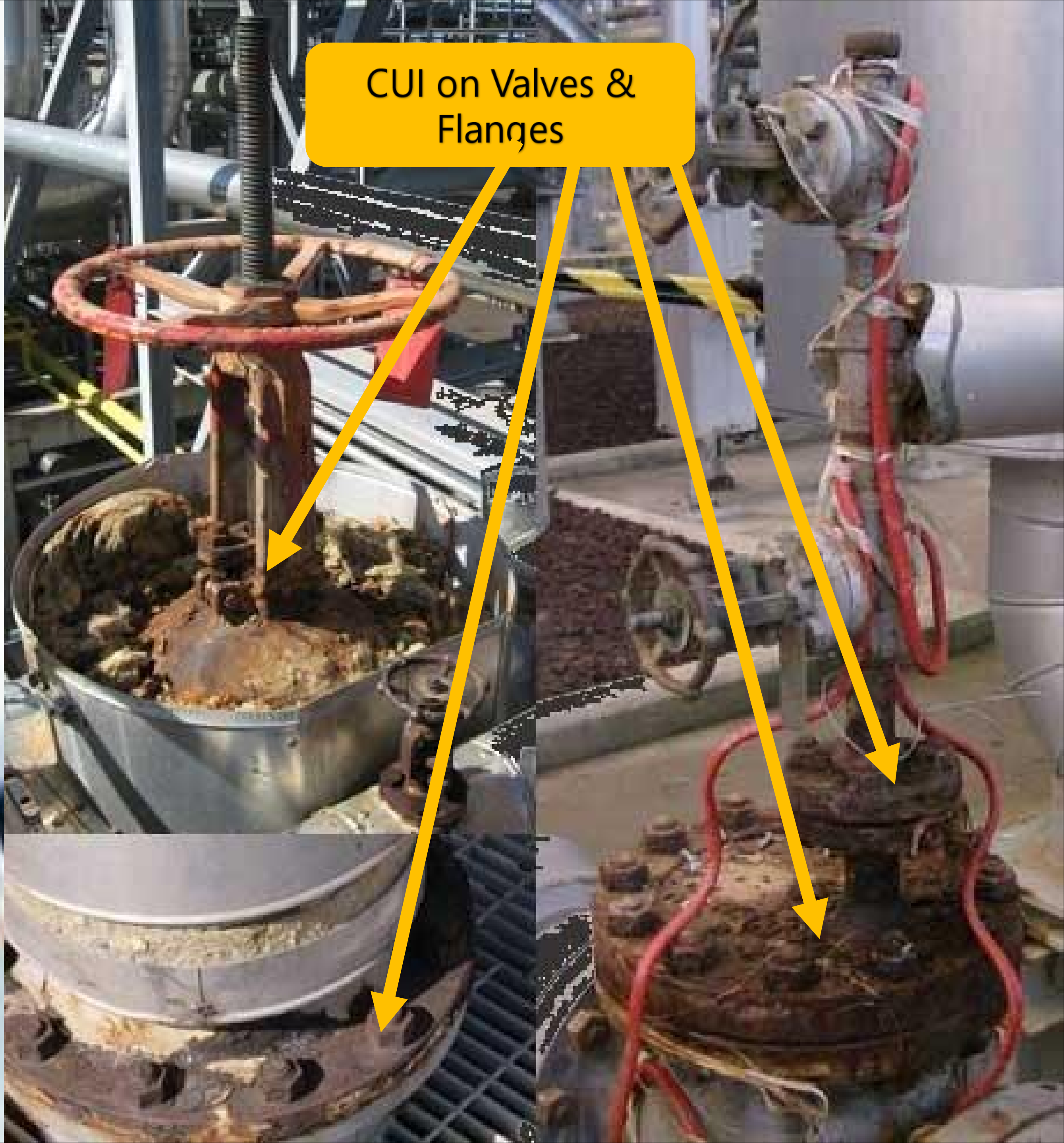


Rusted Weatherproofing

How to Prevent CUI

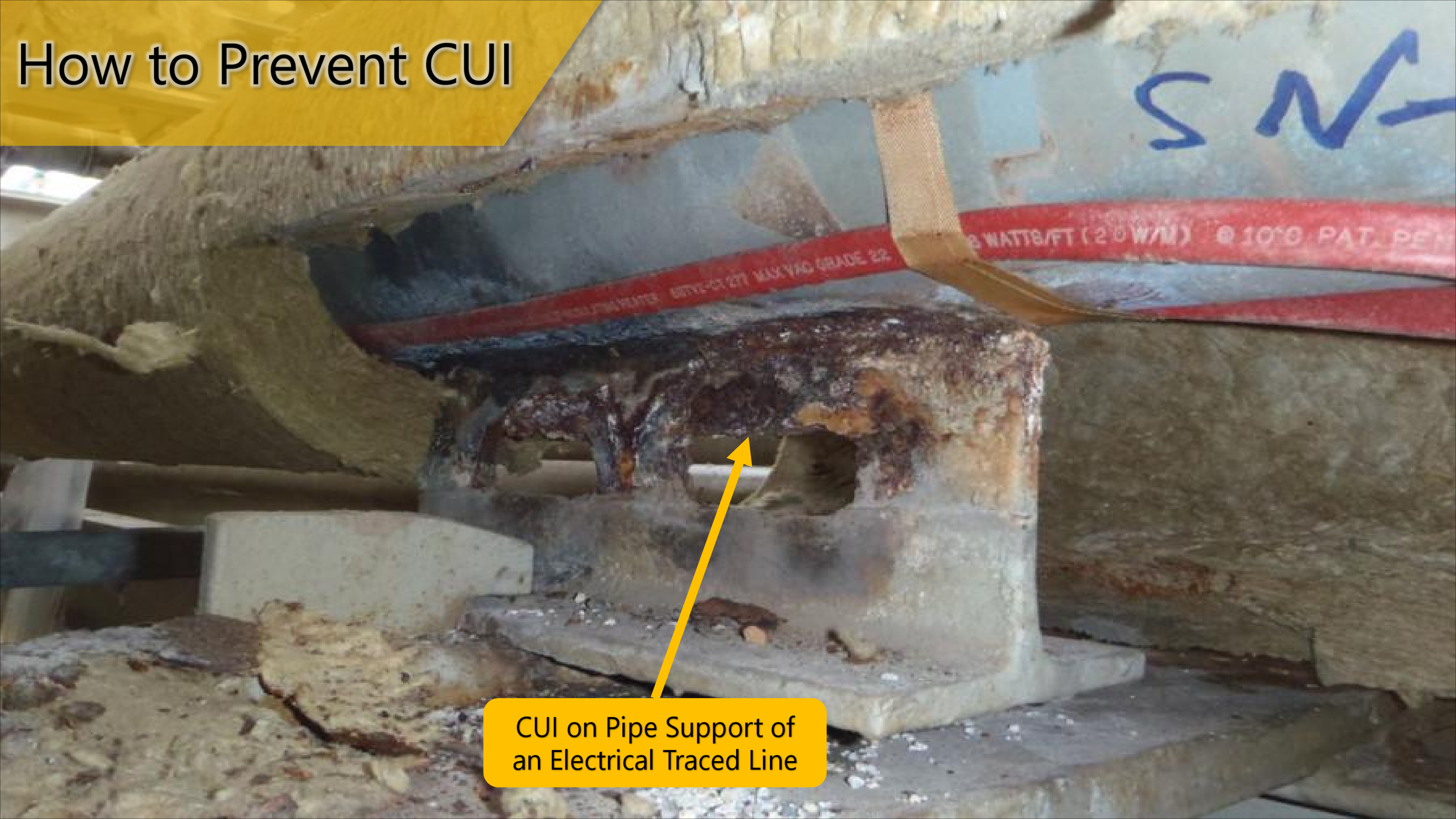


CUI on Straight Pipe



CUI on Valves & Flanges

How to Prevent CUI



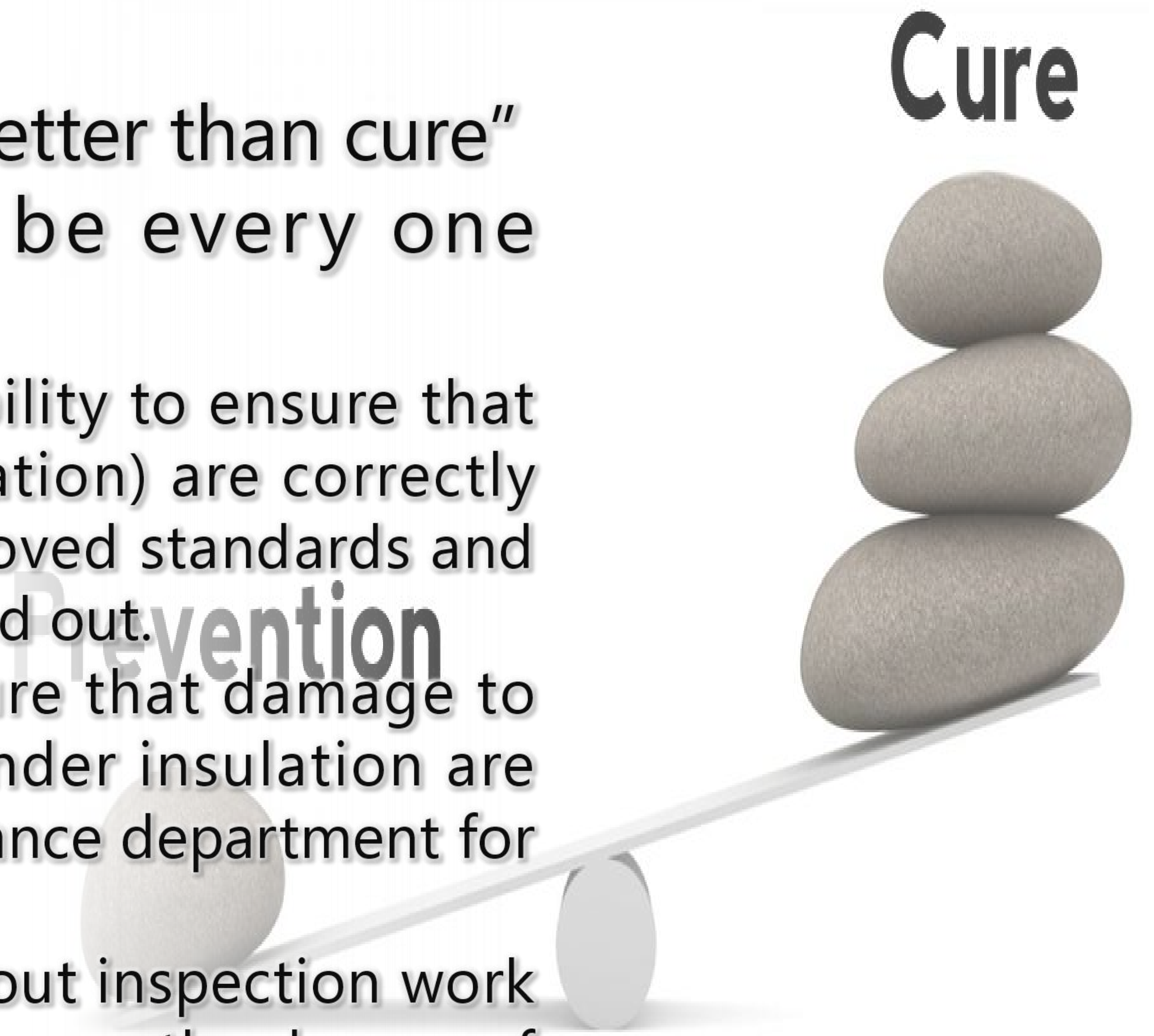
CUI on Pipe Support of an Electrical Traced Line

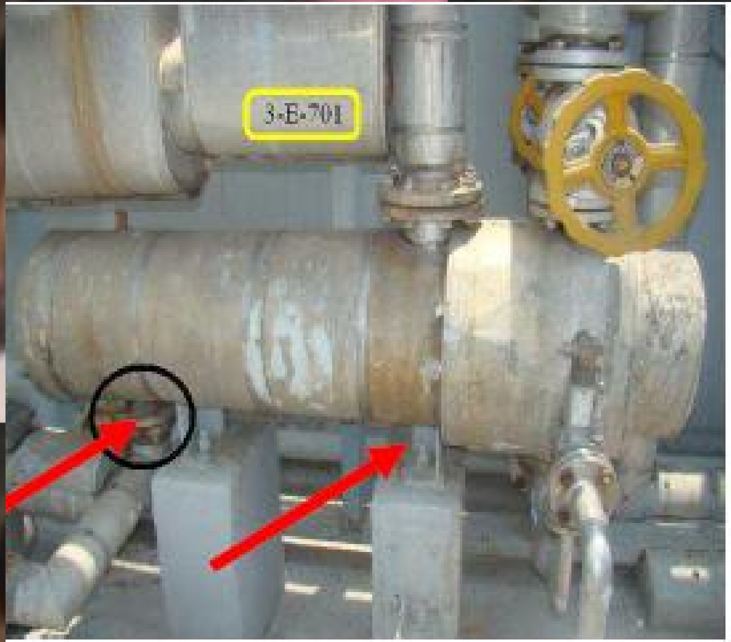
How to Prevent CUI

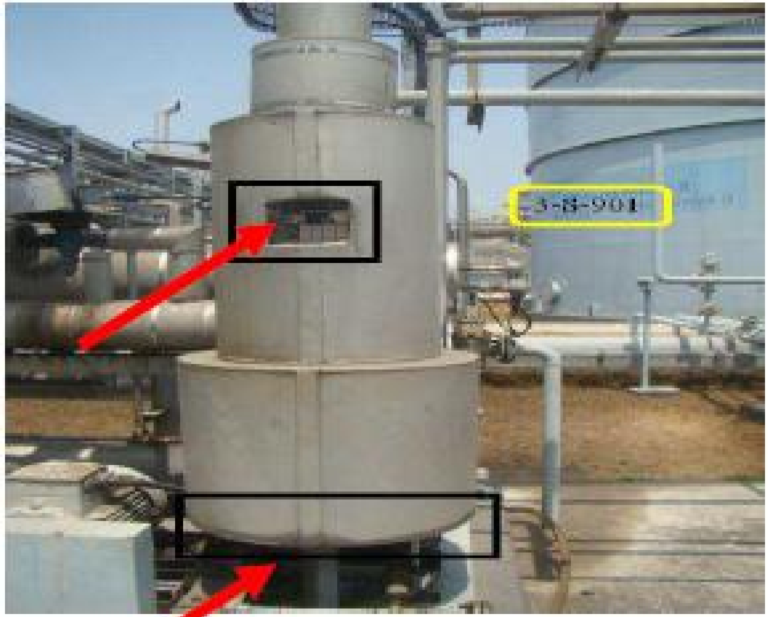
- It is said that the "prevention is better than cure" thus preventing CUI should be everyone responsibility.
    - It is strongly recommended that everyone who is working in a plant is responsible for ensuring that insulated systems are correctly installed, are inspected and are properly maintained.
    - All personnel that are working in the plant are responsible for reporting damage to insulation systems when observed.
    - The higher management must also ensure that there is a culture within the organization that reinforces the need to treat insulated systems in a way that avoids un-necessary damage that would promote CUI.

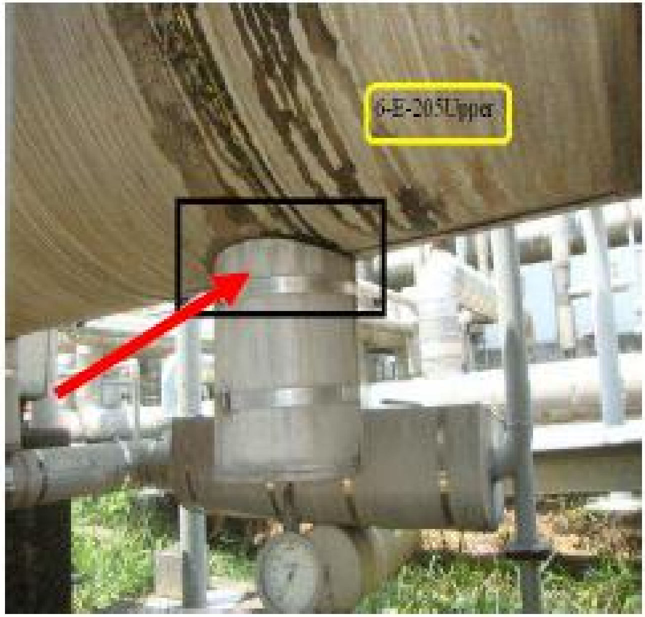
How to Prevent CUI

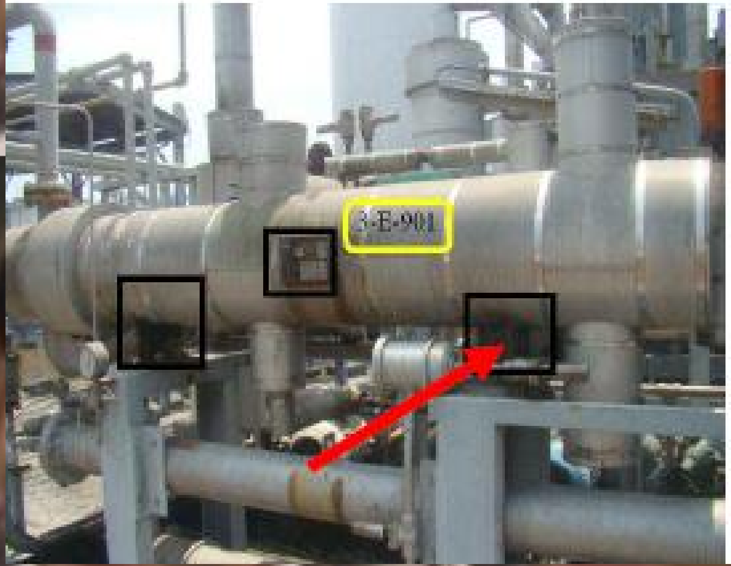
- It is said that the "prevention is better than cure" thus preventing CUI should be every one responsibility.
  - Maintenance department responsibility to ensure that insulated systems (coating & insulation) are correctly installed and maintained using approved standards and that adequate quality checks are carried out.
  - Operation department should ensure that damage to insulation or steam tracing leaks under insulation are reported immediately to the maintenance department for repair.
  - Inspection department should carry out inspection work to locate CUI on insulated systems, assess the degree of corrosion damage, and ensures that appropriate corrective and preventive measures are taken.

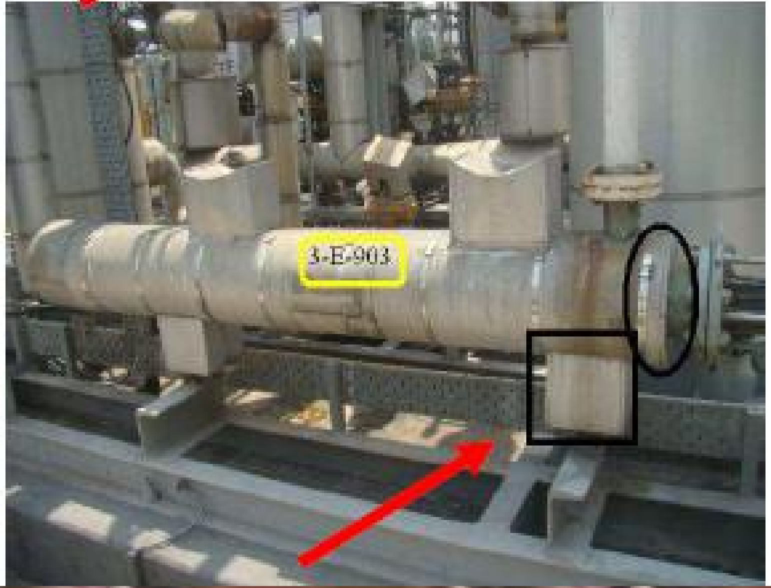


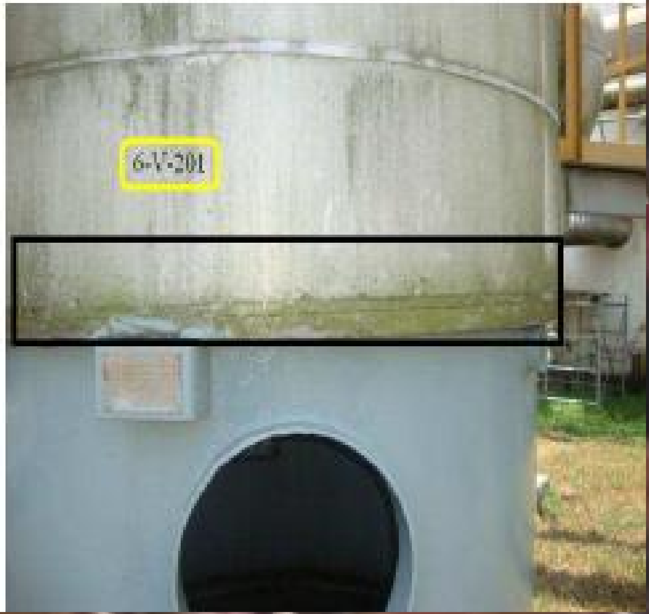

3-E-701


3-B-901


6-E-205Upper


3-E-901


3-E-903


6-V-201

Man in the Picture : Southbore

This man order from me to do his slide.
After i done doing his slide, he refuse
to pay me and banned me instead.
Shame on you...